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ECONOMIC FACTORS IN PACKING AND MARKETING LEMONS IN CARTONS VERSUS STANDARD WOODEN BOXES

R. J. Smith and J. M. Tinley

CALIFORNIA AGRICULTURAL EXPERIMENT STATION
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Foreword

The development of the new lemon half-box carton and the volume fill packing technique was initiated and carried through by the Ventura County Citrus Growers Committee and the senior author. During the course of this investigation the Committee has been reorganized on an industry-wide basis and now has as its members Sunkist Growers, Incorporated, the Mutual Orange Distributors, and The American Fruit Growers, Incorporated. The International Paper Company initiated and carried through the essential work on corrugated paper box board material and box design. The packing houses by undertaking shipments made the contribution that was of primary importance and in this connection specific mention must be made of the first shipments to the eastern United States by the Ventura Pacific Lemon Company, Mr. Carl Samuelson, manager. Many others, of course, both organizations and individuals, far too many to mention, made important and essential contributions.

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ECONOMIC FACTORS IN PACKING AND MARKETING LEMONS IN CARTONS VERSUS STANDARD WOODEN BOXES

Roy J. Smith[1] and J. M. Tinley[2]

Reasons for Study

Early in 1953, a special Citrus Industry Committee on Fungistatic Controls was organized to consider and investigate some of the technical and economic problems arising out of the widespread use of corrugated paper containers (known colloquially as cartons and so referred to in this report) in the shipment of citrus fruit. This Committee requested the Department of Agricultural Economics, University of California, to undertake a study of the economic factors involved in the use of the carton in comparison with the standard wooden box (referred to as the standard box in this report) in the marketing of lemons.

Although some citrus fruit was shipped experimentally in cartons from California as early as 1951, it was not until the latter part of 1952 that any sizable volume of fruit, especially lemons, was packed in this new type of container. In that year it was estimated that between 15 and 20 per cent of all shipments of lemons out of the state were in cartons. In February, 1953, the volume had risen to about 70 per cent and by May to an excess of 80 per cent. In view of this phenomenal expansion over a period of less than a year, it is not improbable that by the end of the 1952-53 season[3] the percentage of lemons shipped in cartons will be even higher.[4] Revolutionary new techniques in handling lemons in packing houses appear to have accompanied the introduction of this new container. Moreover, the carton for lemons appears to have received widespread acceptance by the trade.

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[3] The California citrus season normally is treated as November 1 through October 31 of any two successive years. Sometimes a season is referred to by the second principal year only. 1952-53 is thus sometimes called 1953.

[4] Although oranges have also been shipped in cartons, certain technical and marketing factors appear to have retarded the use of the carton for oranges.

These new developments may have a far-reaching effect upon producers, handlers, and consumers of lemons. Although the new techniques of packing are still in the transition or adoption stage, the special Citrus Industry Committee on Fungistatic Controls considered that it was important to evaluate, even in a preliminary way, the economic advantage and disadvantages arising from the substitution of the carton container for the standard box hitherto in use.

Organization of Study and Report

Field work on this study was undertaken in February, 1953. In order to provide the appropriate economic setting, an analysis was first made of some of the pertinent economic trends affecting the lemon industry of California. Primarily, of course, there was developed an analysis of the old versus the new techniques employed in houses in the physical handling of fruit. As opportunity was afforded some specific information was obtained on material, equipment and labor costs from several packing houses.[5] Finally, an attempt was made to assess in somewhat general terms some of the possible economies or diseconomies in the wholesale and retail markets for lemons that have accompanied the handling of fruit in paper containers.

It must be stressed at the outset that much of the data is preliminary in nature. No packing house has operated for a full fiscal year under the new methods. Only a few houses appear to have stabilized certain phases of their operations. Most houses are still modifying equipment, plant layout, and labor arrangements. Many smaller houses are still continuing to pack fruit in the standard box; others are trying out a half-size wooden box. It is not improbable that operating results will improve later in the year when larger volumes of fruit are handled and when transitional difficulties have been corrected.

In particular it must be stressed that tiere was no opportunity for a formal and detailed investigation of the situation in the wholesale and retail markets.

5/ Mr. George Ferguson of the California Citrus League assisted the authors in gathering information from packing houses.

Economic Trends in the Lemon Industry

Acreage, Production and Utilization.--Virtually all the lemons produced in the United States are grown in California--in fact, in the southern one third of the state. Bearing acreage in lemons showed no perceptible trend between 1924-25 and 1936-37, year-to-year fluctuations being between 40,000 and 42,000 acres (see Figure 1). From 1937-38, however, bearing acreage expanded rapidly to reach a record high of 66,000 acres in 1946-47, since when there has been an appreciable decline to just under 55,000 acres in 1950-51 and 1951-52. Part of this decline has been more apparent than real. In 1948 and 1949, a state-wide tree count was conducted as a result of which revised and more accurate estimates of bearing and non-bearing acreage in citrus fruit were made. The tree count survey indicated that estimates of bearing acreage in previous years were probably too high. Although some of the apparent decline in bearing acreage in 1949-50 and 1950-51 represented merely an adjustment of data, other evidence available indicates that there has been, nevertheless, an appreciable decrease in bearing acreage in lemons since 1946-47.

One of the important factors supporting this conclusion is the decline in recent years in non-bearing acreage in lemons. Non-bearing acreage increased rapidly and steadily from 1,700 acres in 1927-28 to 18,400 acres in 1936-37, declined moderately to 11,600 acres by 1942-43, but then fell off sharply to 2,300 acres in 1947-48 (Table 1). Since then, non-bearing acreage in lemons has increased somewhat but in 1950-51 was still well under the levels attained during the immediate pre-World War II period. The decline in bearing acreage since 1939-40 indicates that sufficient new groves are not being planted to replace old groves which have passed profitable commercial operation. In spite of the moderate upturn in non-bearing acreage in recent years, it is probable that some further decline in bearing acreage is in prospect during the next few years.

Yields per acre of lemons tend to fluctuate rather widely from year to year. Nevertheless, between 1924-25 and 1940-41 there was a distinct upward trend in average yields of lemons per acre (Figure 2). In 1940-41 an all-time record yield of 318 packed box equivalents per acre was obtained. Since then, there has been a moderate downward trend in yield. It is probable that the apparent increase in yields per acre shown for 1949-50 and 1950-51 was due in part to the downward revision of bearing acreage as a result of the tree count.

[illegible]

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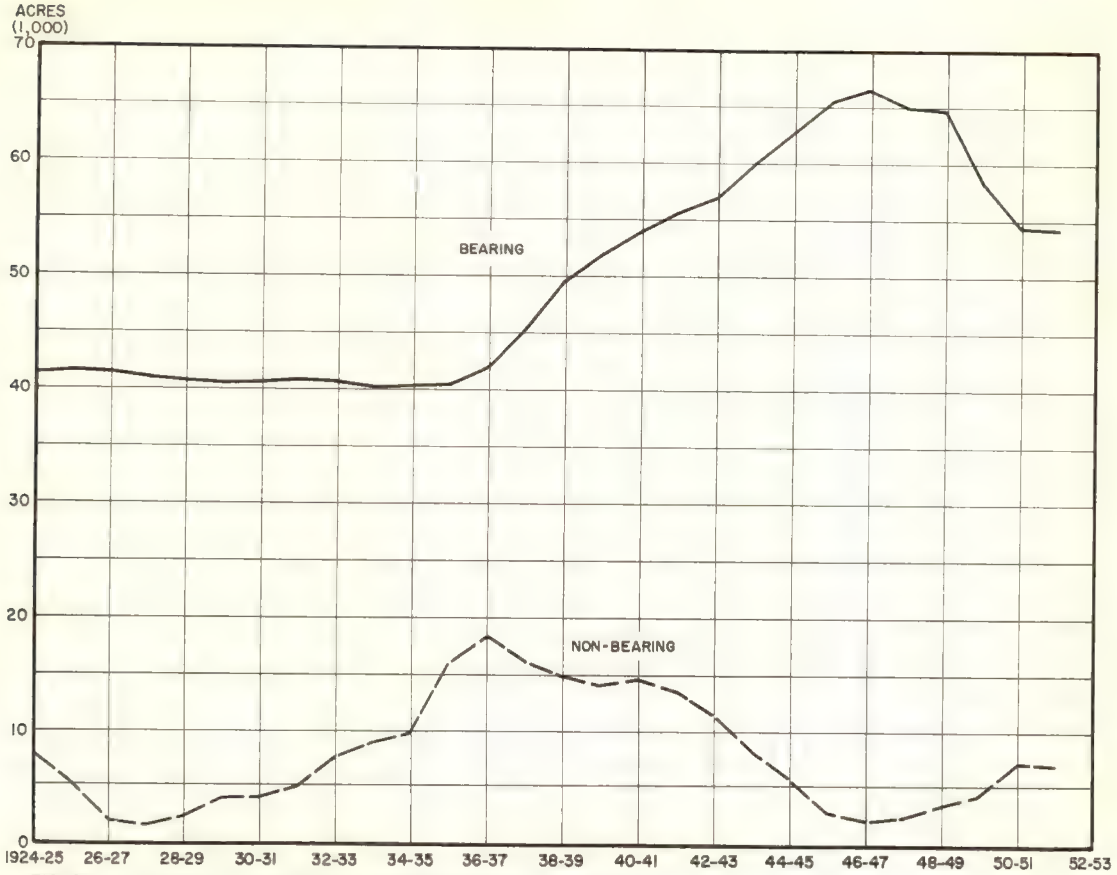

FIGURE I. ACREAGE PLANTED TO LEMONS. (1924-25 TO 1951-52)
SOURCE: TABLE I.

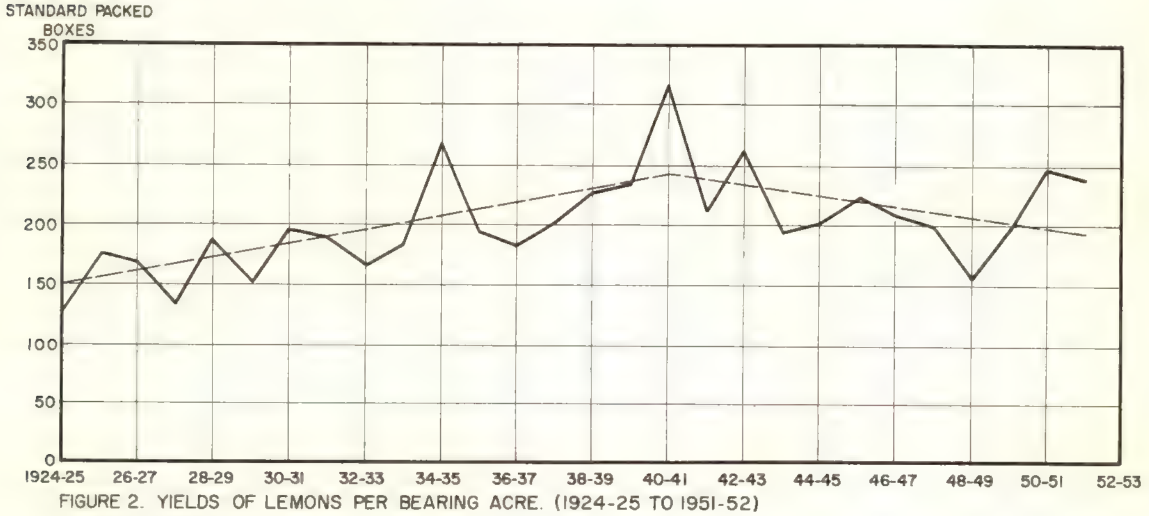

FIGURE 2. YIELDS OF LEMONS PER BEARING ACRE. (1924-25 TO 1951-52)
SOURCE: TABLE I.

Table 1

Acreage and production of lemons
(standard box equivalent)

Year	Acreage (1000 acres)		Yield per bearing acre	Production (mil.boxes)
	Bearing	Non-bearing		
1924-25	41.3	7.7	128	5.3
25-26	41.6	5.4	175	7.3
26-27	41.5	2.2	166	6.9
27-28	41.0	1.7	132	5.4
28-29	40.8	2.6	186	7.6
1929-30	40.5	4.1	151	6.1
30-31	40.7	4.2	194	7.9
31-32	41.0	5.1	188	7.7
32-33	40.7	7.7	165	6.7
33-34	40.2	9.1	182	7.3
1934-35	40.4	9.9	267	10.8
35-36	40.6	16.1	192	7.8
36-37	42.1	18.4	181	7.6
37-38	45.4	16.2	205	9.3
38-39	49.4	14.8	225	11.1
1939-40	52.0	14.1	231	12.0
40-41	54.1	14.6	318	17.2
41-42	55.7	13.6	210	11.7
42-43	57.1	11.6	261	14.9
43-44	60.1	8.4	183	11.0
1944-45	62.7	5.9	201	12.6
45-46	65.5	3.0	221	14.5
46-47	66.6	2.3	207	13.8
47-48	64.9	2.5	199	12.9
48-49	64.7	3.7	155	10.0
1949-50	58.2	4.5	196	11.4
50-51	54.4	7.3	247	13.4
51-52	54.3	7.1	236	12.8
5 year average				
24-25 to 28-29	41.2	3.9	157	6.5
29-30 to 33-34	40.6	6.0	176	7.1
34-35 to 38-39	43.6	15.1	214	9.3
39-40 to 43-44	55.8	12.5	241	13.4
44-45 to 48-49	64.9	3.5	197	12.8

Source: Sunkist Growers, Inc. Statistical Information on the Citrus Fruit Industry, 1951 and Supplement, 1953. Table 9.

Three rather distinct trends are shown in lemon production between 1924-25 and 1951-52 (Figure 3). Up to 1936-37, production increased moderately, though irregularly, the increase in large measure being associated with increased yields per acre. Between 1936-37 and 1940-41, production of lemons increased sharply to the all-time peak of 17,200,000 pack box equivalents in the latter year, the result of both increasing bearing acreage and higher yields per acre. Since 1940-41, total production of lemons has tended to fluctuate rather violently from year to year, although the average level of production was distinctly higher than during the years prior to 1936-37. Noticeable, however, is a rather definite, though moderate, downward trend in annual output. This decline in recent years is due not only to the decline in acreage but also due to the increased age of groves and to cultural difficulties.

Consumption of fresh lemons, as measured by shipments of fresh fruit, increased more or less steadily between 1924-25 and 1944-45 since when the volume of consumption of fresh fruit has been moderately downward (Figure 3). The decline in 1947-48 and 1948-49 appears to have been particularly sharp. Part of the decline in 1948-49 was probably due to the low production and poor quality of fruit in that year as a result of the severe freeze. It is not unlikely, however, that part of the drop can be ascribed to increasing competition from canned and frozen fruit juices of all kinds. Since 1948, the new juice products (canned single strength lemon juice and frozen concentrate for lemonade and lemonade mix) have become an important and bright spot in the lemon consumption picture. They have increased in sales rapidly and have offered a return to growers which while not equal to that of fresh fruit yet has been immeasureably better than that of other products. Pertinent details are shown in Tables 1 and 2 and in Figure 3.

It is significant in this connection that during the 15-year period, 1924-25 to 1938-39, about 80 per cent of all lemons produced annually was shipped in fresh form (Figure 4). During the years 1939-40 to 1943-44 only 67 per cent was so shipped. Only about 51 per cent of the record crop of 1940-41 could be absorbed in the fresh fruit market. During the years 1944-45 to 1948-49 about 70 per cent of the crop was shipped fresh, but smaller proportions were so shipped in the years 1949-50 and 1950-51.[6]

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[6] It is not improbable that part at least of the smaller volume of fruit shipped fresh in recent years may be due to the restrictions imposed under the Lemon Marketing Agreement.

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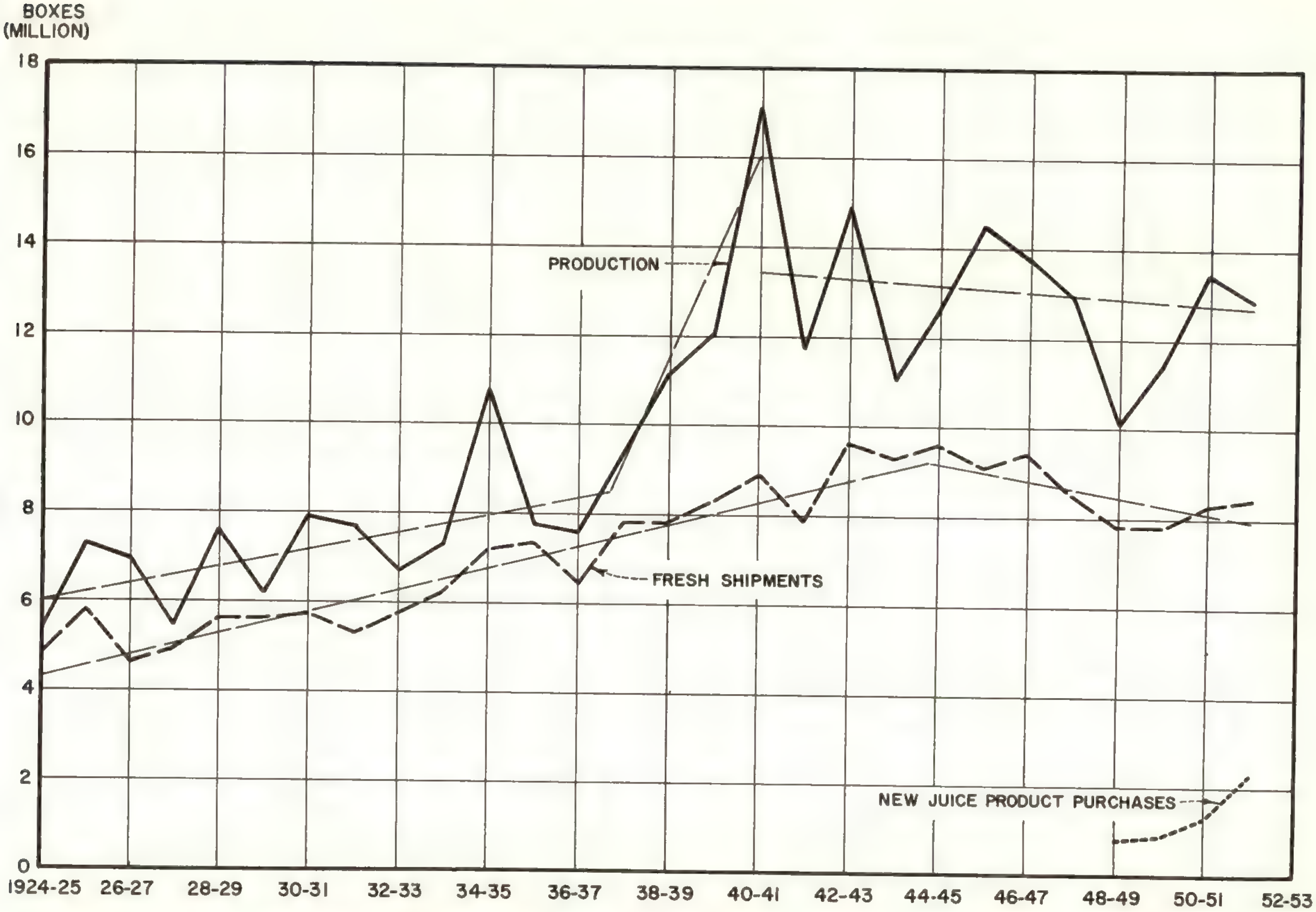

FIGURE 3. PRODUCTION, FRESH SHIPMENTS, AND NEW JUICE PRODUCT PURCHASES OF LEMONS. 1924-25 TO 1951-52. (STANDARD BOX EQUIVALENT.)
SOURCE: TABLE 2.

Table 2

Production and principal utilization of lemons
(standard box equivalent)

Year	Production	Fresh shipments		New juice product purchases	
	(mil.boxes)	(mil.boxes)	(per cent)	(mil.boxes)	(per cent)
1924-25	5.3	4.8	91	no data	no data
25-26	7.3	5.8	79		
26-27	6.9	4.6	67		
27-28	5.4	4.9	91		
28-29	7.6	5.6	74		
1929-30	6.1	5.6	92		
30-31	7.9	5.7	72		
31-32	7.7	5.3	69		
32-33	6.7	5.7	85		
33-34	7.3	6.2	85		
1934-35	10.8	7.2	67		
35-36	7.8	7.4	95		
36-37	7.6	6.5	85		
37-38	9.3	7.8	84		
38-39	11.1	7.8	70		
1939-40	12.0	8.3	69		
40-41	17.2	8.9	51		
41-42	11.7	7.9	67		
42-43	14.9	9.6	65		
43-44	11.0	9.3	84		
1944-45	12.6	9.6	77		
45-46	14.5	9.1	63		
46-47	13.8	9.4	68		
47-48	12.9	8.5	66		
48-49	10.0	7.8	78	0.8	9
1949-50	11.4	7.8	68	0.9	8
50-51	13.4	8.3	62	1.3	10
51-52	12.8	8.4	65	2.3	18
5 year average					
24-25 to 28-29	6.5	5.1	80		
29-30 to 33-34	7.1	5.7	81		
34-35 to 38-39	9.3	7.3	80		
39-40 to 43-44	13.4	8.8	67		
44-45 to 48-49	12.8	8.9	70		

Source: Sunkist Growers, Inc. Statistical Information on the Citrus Fruit Industry, 1951 and Supplement, 1953. Tables 9 and 33.

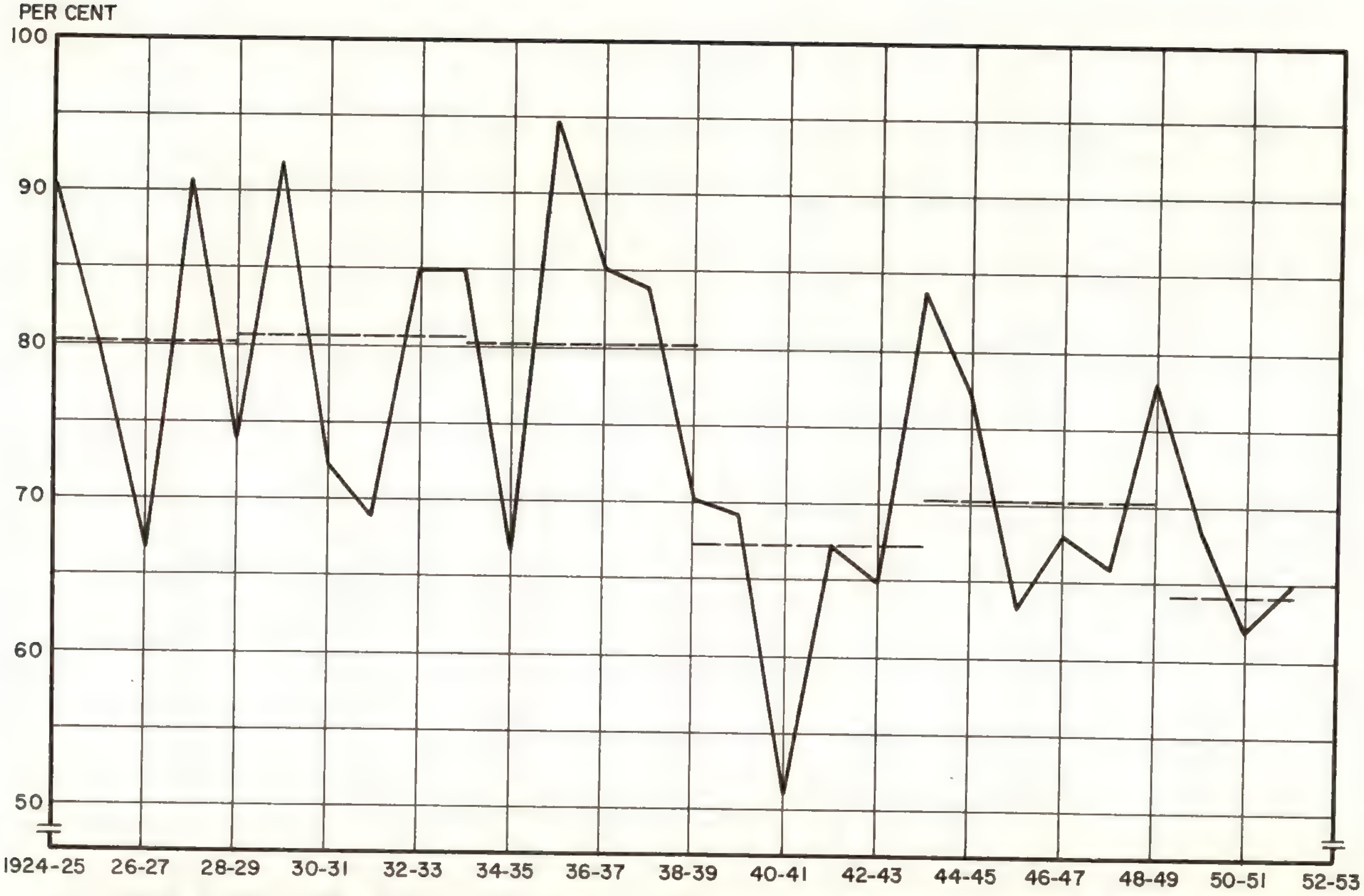

FIGURE 4. PER CENT OF LEMONS SHIPPED FRESH (1924-25 TO 1951-52) WITH 5 YEARS AVERAGES.
SOURCE: TABLE 2.

These downward trends in the production and fresh utilization are of particular significance relative to packing house operations. Unless lemon packing houses are able to contract the size of their operations, something that is difficult to accomplish with fixed size of buildings and equipment, unit packing costs are likely to rise--quite apart from any increase in the prices of cost factors. A recent study made in the area served by the Ontario-Cucamonga Fruit Exchange indicated rather clearly that there is a direct inverse relation between volume of fruit handled and per cent of capacity utilized and unit costs of packing fruit.[7/]

Bearing Acreage by Counties.--Some marked shifts have occurred in the last 15 years or so in the relative importance of counties in regard to bearing acreage in lemons. During the period 1920-1935, bearing acreage in lemons declined to a minor extent in Los Angeles, Orange and San Bernardino counties and to a relatively greater extent in Tulare and Riverside counties (Table 3). On the other hand, increases in acreage were registered for San Diego, Santa Barbara, and Ventura counties. The net effect for the state as a whole was an increase of bearing acreage from 38,200 acres in 1920 to 40,600 acres in 1935.

During the period 1935-46, bearing acreage just about tripled in Ventura and Santa Barbara counties. Gains of around 50 per cent were registered in San Bernardino and San Diego counties, of around 20 per cent in the Los Angeles and Orange counties, and of 10 per cent or less in Tulare and Riverside counties. Between 1946 and 1951 bearing acreage declined in all the counties. The most severe decline (almost 40 per cent) occurred in Orange County. In two other counties (Tulare and San Diego) the decline was in excess of 20 per cent, in four counties (Los Angeles, Riverside, San Bernardino, and Santa Barbara), between 13 and 17 per cent, and in Ventura, only about 10 per cent. It should be stated again that part of the apparent decline in 1949 and 1950 was probably associated with the readjustment of estimates following the tree count.

[7/] Tinley, J. M. and Parks, G. W. Consolidation of Citrus Packing Houses in the Ontario-Cucamonga Area. Berkeley, June 1953. (Giannini Foundation of Agricultural Economics, University of California. Mimeographed Report No. 154) [illegible] Unless lemon packing houses are able to contract the size of their operations, something that is difficult to accomplish with fixed size of buildings and equipment, unit packing costs are likely to rise--quite apart from any increase in the prices of cost factors. A recent study made in the area served by the Orange [illegible] direct inverse relation between volume of fruit handled and per cent of capacity utilized and unit costs of packing fruit.[1]

Shifting Acreage by Counties.--Some marked shifts have occurred in the last 15 years or so in the relative importance of counties in regard to bearing acreage in lemons. During the period 1920-1935, bearing acreage in lemons declined to a minor extent in Los Angeles, Orange and San Bernardino counties and to a relatively greater extent in Tulare and Riverside counties (Table 3). On the other hand, increases in acreage were registered for San Diego, Santa Barbara, and Ventura counties. The net effect for the state as a whole was an increase of bearing acreage from 38,700 acres in 1920 to 40,500 acres in 1935.

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[1] [illegible] Department of Agricultural Economics, University of California, Mimeographed Report No. 124)

Table 3
Bearing acreage of lemons in California by counties (1000 acres)

Year	Tulare	Los Angeles	Orange	Riverside	San Bernardino	San Diego	Santa Barbara	Ventura	All other counties	Total state
1920	1.5	10.7	6.5	4.5	4.4	4.0	1.0	4.7	.9	38.2
1925	1.4	11.6	6.9	4.2	5.2	4.2	1.4	5.5	1.1	41.6
1930	1.3	11.4	6.8	3.4	4.6	4.7	1.7	5.6	1.2	40.7
1935	1.1	10.2	6.4	3.5	4.3	4.9	2.7	6.3	1.0	40.6
1936	1.1	10.1	6.5	3.5	4.5	5.1	3.0	7.4	.9	42.1
1937	1.1	10.0	6.8	3.5	4.7	5.5	3.6	9.2	.9	45.4
1938	1.2	10.5	7.1	3.5	4.9	6.0	4.5	10.7	.9	49.4
1939	1.2	11.1	7.4	3.6	5.2	6.5	4.8	11.5	.7	52.0
1940	1.2	11.5	7.5	3.6	5.4	6.8	5.3	12.3	.7	54.1
1941	1.2	11.7	7.3	3.6	5.6	6.9	5.8	12.9	.6	55.7
1942	1.2	11.9	7.1	3.6	5.8	7.0	6.3	13.6	.6	57.1
1943	1.2	12.1	7.2	3.7	6.1	7.3	6.9	15.2	.5	60.1
1944	1.3	12.2	7.4	3.7	6.2	7.3	7.7	16.5	.4	62.7
1945	1.2	12.2	7.9	3.7	6.3	7.4	8.2	18.0	.5	65.5
1946	1.3	12.2	7.9	3.7	6.3	7.5	8.4	18.7	.5	66.6
1947	1.3	12.1	7.9	3.7	6.3	7.2	8.6	17.3	.4	64.9
1948	1.3	11.6	7.9	3.6	6.2	7.0	8.6	17.9	.4	64.7
1949	1.1	10.7	5.2	3.2	5.7	5.4	8.8	17.7	.4	58.2
1950	1.0	10.4	4.9	3.2	5.6	5.4	6.8	16.5	.4	54.4
1951	1.0	10.1	4.8	3.2	5.5	5.4	7.1	16.9	.3	54.3

Source: 1920-1946. Unpublished revised estimates of bearing acreage of California Lemons from R. E. Blair, California Crop and Livestock Reporting Service, Sept. 13, 1950.

1947-1951. California Fruit and Nut Acreage, California Cooperative Crop Reporting Service, Annual Reports.

The change in the relative importance of the various counties by 10-year intervals is shown in Table 4 and Figure 5. In 1920, Los Angeles County was in first place, Orange County was second, Ventura County, third, Riverside County, fourth, and Santa Barbara, seventh. In 1950, Ventura County was first and Los Angeles County second. Santa Barbara had moved up to third place, while Orange and Riverside counties had dropped down to the sixth and seventh position. In other words the two more northerly coastal counties had increased greatly in relative importance as regards lemon production, whereas the counties south of Ventura and the Tehachapi Mountains had declined in relative importance. In 1920, Ventura and Santa Barbara counties together accounted for only about 14 per cent of all bearing acreage in lemons, whereas in 1950, they accounted for about 43 per cent.

Table 4

Percentage of bearing acreage of California lemons
by counties, by ten-year intervals.

Year	Los Angeles	Orange	Riverside	San Bernardino	San Diego	Santa Barbara	Ventura	All other counties	Total, state
1920	28.8	16.3	12.3	11.2	11.3	2.8	11.5	6.2	100.0
1930	27.9	16.8	8.3	11.3	11.5	4.2	13.8	6.2	100.0
1940	21.2	13.8	6.6	10.0	12.6	9.7	22.7	3.4	100.0
1950	19.2	9.1	5.9	10.3	9.9	12.5	30.4	2.7	100.0

Source: Hoos, Sidney and Seltzer, R. E. Lemons and Lemon Products, Changing Economic Relationships, 1951-52, Berkeley, October, 1951, p. 3. (Statistical Supplement to Agricultural Experiment Station Bulletin No. 729).

These intercounty shifts of bearing acreage in lemons have a special significance in regard to packing house operations. In the two coastal counties, there is sufficient volume of fruit to enable packing houses to operate more nearly at full capacity--in fact, some areas of Ventura and Santa Barbara counties may need more packing house facilities. In contrast, there appear to be more packing house facilities in the counties south of Ventura County and of the Tehachapi Mountains than are needed. In some parts of this area, several lemon packing houses have been closed down during the past few years; several more are on the verge of closing down or of consolidating

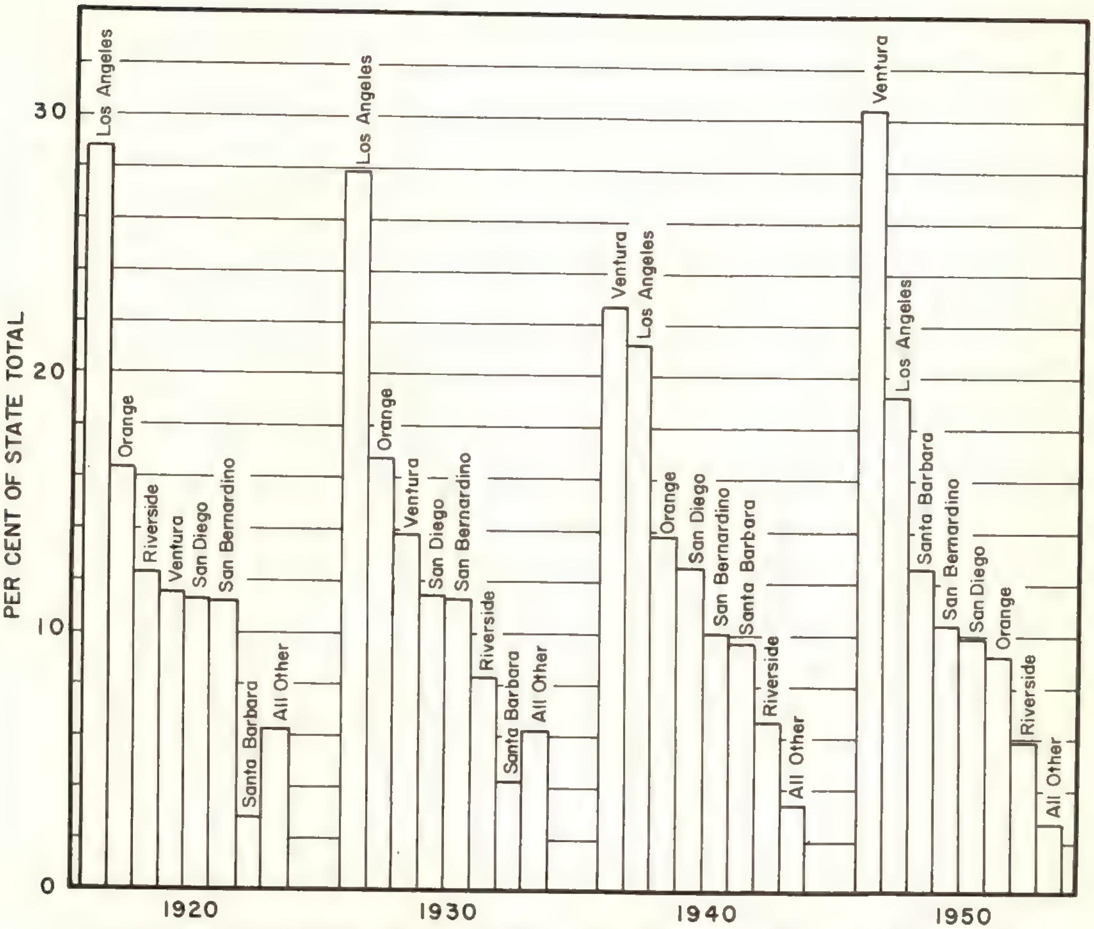

FIGURE 5. PERCENTAGE OF BEARING ACREAGE OF CALIFORNIA LEMONS BY COUNTIES, BY TEN YEAR INTERVALS.

SOURCE: TABLE 4

operations.

It is apparent from these differences in production trends among the counties that the profitableness of lemon plantings have varied widely.

Reasons for Trends in Acreage, Production and Utilization.--The question may well arise as to what economic and other factors may be behind the trends in acreage, production, and utilization described above. These factors may be grouped under two main, though interrelated, headings--cultural and economic. Cultural factors would include environmental conditions limiting areas suitable for lemon production, age of orchards, and such problems as disease, rainfall, and water tables. The economic factors would include competition for lands suitable for lemon production, the relative profitability of lemon production, and competition between fresh fruit and fruit juices.

The area suitable for lemon production is limited because of the rather selective environmental requirements of lemons in regard to climate, soil conditions and water needs. Lemons are even more rigid in regard to such requirements than are most other types of citrus fruit--hence the concentration of the United States production in a few counties in the southern part of California. In the main, new acreage can be brought into production only within the present general areas of production. Much of this potential acreage can be brought into cultivation only at the expenditure of considerable sums of capital for leveling, irrigation and drainage. It is probable that, unless important cultural changes develop (for example, propagation of new varieties of lemons with less rigid environmental requirements), the amount of new land not now planted to other products that can be brought into lemon production is severely limited.

Production on existing acreage may be adversely affected by the development of new diseases, the increasing difficulty of combating older diseases, the increasing age of trees with concomitant declines in yields per acre, periods of declining rainfall and falling water tables, and the accumulation of deleterious minerals in the soils from years of irrigation. Moreover, it is frequently found that, when old acreages of lemons are pulled out and replanted to new trees, the yields per acre in the replanted groves are below those obtained previously in the old groves.[8]

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[8] It is understood that recent cultural developments (for example, use of soil fumigants in replanting, development of new varieties, and better bud and root stocks) give promise of better results in replanting old acreage.

[illegible]

[illegible]

be grouped under two main, though interrelated, headings--cultural and eco- nomic. [illegible] areas suitable for lemon production, age of orchards, and such problems as disease, rainfall, and water tables. The economic factors would include com- petition for lands suitable for lemon production, the relative profitability of lemon production, and competition between fresh fruit and fruit juice.

The area suitable for lemon production is limited because of the rather exacting environmental requirements of lemons in regard to climate, soil conditions and water needs. Lemons are even more rigid in regard to such re- quirements than are most other types of citrus fruits--hence the concentration of the United States production in a few counties in the southern part of California. In the main, new acreage can be brought into production only within the present natural areas of production. Much of this potential acreage at this time is available only at the expenditure of considerable [illegible] for land leveling, irrigation and drainage. It is apparent that, unless important cultural changes develop (for example, production of new varieties of lemons with less rigid environmental requirements), the amount of the land not now planted to other products that can be brought into lemon production is severely limited.

Production on existing acreage may be adversely affected by the develop- ment of tree disease, the increasing difficulty of obtaining needed water, the increasing age of trees with consequent declines in yields per acre, periods of declining rainfall and falling water tables, and the accumulation of deleterious minerals in the soils from years of irrigation. However, it is frequently found that, when old acreages of trees are pulled out and re- planted to new trees, the yields per acre on the replanted groves are below [illegible][1]

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[1] It is recognized that recent cultural developments (for example, use of [illegible] in replanting, development of new varieties, and [illegible] and [illegible]) give promise of better results in replanting old groves.

In regard to the economic factors, it may be as well to state at the outset that, while numbers of retired and other persons have acquired citrus groves for other than economic reasons, the great majority of growers, individuals or corporations, have undertaken citrus production as a commercial proposition. For large numbers of growers, income from the citrus enterprise is the main or an important supplementary source of income. They are thus guided by the profit motive as are producers of other agricultural products or persons engaged in other forms of business. Because of this economic urge, the acreage planted to lemons and other citrus fruit is likely to expand (within limits) when net returns per acre obtained from the sale of fruit are expanding and to contract when net returns are declining.

Considerable land suitable for lemon production is now planted to other horticultural crops, such as walnuts, avocados and oranges, to ornamental crops or to vegetable crops. Most of the lands now planted to lemons can, of course, be planted to these other crops. Lemon growers are interested in comparative net returns--from lemons in comparison with alternative products. If a grower believes that in the long run he can earn more per acre by producing a competing product (for example, avocados) than from lemons, he will tend to replant his acreage to avocados and vice versa. Thus during the 1930's much of the expansion of acreage in lemons was at the expense of land previously planted to walnuts. On the other hand, during recent years much lemon acreage in southern California has been replanted to avocados.

Competition for lemon acreage may come from non-agricultural sources. Land used for urban subdivision, for industrial sites and for highways has a much higher value per acre than if devoted to agricultural production. During and especially since the end of the war, much citrus acreage (including that of lemons) has been lost to urban development in southern California. Informed people claim that much of the land so lost had been planted previously to comparatively high-yielding groves.

A comparison of prices received for fruit with cultural and marketing costs will aid in explaining trends of acreage (especially new acreage) planted to lemons. The California Citrus League has published for a considerable number of years annual estimates of average f.o.b. prices obtained by packing houses, and average cultural, picking and hauling, packing, and [illegible] viduals or corporations, have [illegible] production. For large numbers of growers, income from the citrus enterprise is the main or an important supplementary source of income. They are being guided by the profit motive as are producers of other agricultural products or persons engaged in other forms of business. Because of this economic urge, the acreage planted to lemons and other citrus fruit is likely to expand (within limits) when net returns per acre obtained from the sale of fruit are expanding and be contracted when net returns are declining.

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A comparison of prices received for fruit with returns and marketing costs will aid in explaining trends in acreage (especially new acreage) planted to lemons. The California Fruit Growers Exchange has published for a considerable number of years annual estimates of average f.o.b. prices obtained by [illegible] selling and advertising costs, all on a packed box equivalent basis.[9] While many of these estimates may be open to question in any one year, they do afford a reasonably accurate reflection of long-time changes in these price and cost factors. These data are shown in Table 5. Data showing absolute changes in prices and costs are not too meaningful because such prices tend to rise and fall over periods of several years but at different rates. Relative or percentage changes in price around a particular base period make possible more realistic appraisals for these price-cost relations. These are shown in Table 6 with the 5-year period 1934-35 to 1938-39 as base.

Relative changes in f.o.b. prices, in total cultural and marketing costs, and in packing costs as well as data on non-bearing acreage are shown graphically in Figure 6. It will be noticed that between 1924-25 and 1936-37 relative f.o.b. prices of lemons were consistently (except for 1925-26) on a higher level than were the indexes of total cultural and marketing costs. This period was relatively favorable for the production of lemons. It is significant that non-bearing acreage in lemons expanded from 1,700 acres in 1927-28 to 18,400 acres in 1936-37.

During the period 1937-38 to 1947-48, the index of costs was above the index of f.o.b. prices in every year except 1942-43 and 1943-44, indicating that during this period lemon production was relatively less profitable. Again, it is significant that during this period non-bearing acreage planted to lemons declined steadily to less than 3,000 acres in 1947-48. The price-cost ratio was apparently more favorable during the years 1948-49 to 1951-52. Non-bearing acreage planted to lemons increased during these years. This period is too short to permit any conclusions as to whether the previous downward trend in bearing acreage has now been reversed. Part of the increase may be due to the reclassification of acreage resulting from the "tree count".

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[9] By using f.o.b. prices, it is possible to ignore trends in transportation and marketing costs--costs interposed between the price received by packing houses and the prices paid by consumers for fresh fruit. Transportation costs have risen steadily from $1.18 per packed box in 1936-37 to $1.69 in 1952-53. Sumilar increases have taken place in refrigeration costs. The absolute margins of wholesale dealers and retail stores have also risen materially since 1939-40.

[illegible]

[illegible]

[illegible]

[illegible]

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a/ [illegible]

Table 5

F.o,b. prices, cultural and marketing cost per box (in dollars) 1924-25 to 1951-52

Cultural year	Weighted average f.o.b. prices	Cultural costs	Picking & hauling costs	Pack-ing costs	Selling & adver-tising costs	Total four cost items
1924-25	4.55	1.49	.46	.93	.16	3.04
25-26	3.26	1.06	.47	.88	.14	2.55
26-27	3.97	.93	.40	.90	.15	2.38
27-28	4.84	1.57	.45	.85	.19	3.06
28-29	4.64	1.10	.45	.85	.16	2.56
1929-30	5.10	1.70	.43	.85	.19	3.17
30-31	3.99	1.00	.44	.84	.17	2.45
31-32	3.63	.96	.39	.83	.18	2.36
32-33	3.43	1.00	.34	.75	.17	2.26
33-34	3.63	.93	.35	.73	.17	2.18
1934-35	2.93	.61	.32	.78	.16	1.87
35-36	4.21	1.20	.36	.77	.17	2.50
36-37	4.46	1.44	.39	.85	.18	2.86
37-38	3.04	1.09	.40	.80	.16	2.45
38-39	2.87	.85	.37	.81	.18	2.21
1939-40	3.02	.94	.36	.80	.17	2.27
40-41	2.92	.41	.34	.85	.18	1.78
41-42	3.27	.77	.40	1.01	.18	2.36
42-43	4.63	.72	.55	1.11	.19	2.57
43-44	5.11	1.14	.61	1.20	.20	3.15
1944-45	4.72	1.13	.67	1.24	.20	3.24
45-46	4.41	1.17	.63	1.32	.23	3.35
46-47	5.38	1.35	.67	1.41	.24	3.67
47-48	5.49	1.33	.71	1.53	.25	3.82
48-49	7.03	1.94	.74	1.59	.27	4.54
1949-50	6.01	1.30	.73	1.55	.28	3.86
50-51	5.86	1.16	.74	1.60	.31	3.81
51-52	6.45	1.40	.78	1.62	.30	4.10
Averages						
1924-25 to 28-29	4.05	1.23	.45	.88	.16	2.72
1929-30 to 33-34	3.96	1.12	.38	.80	.18	2.48
1934-35 to 38-39	3.52	1.04	.37	.80	.17	2.38
1939-40 to 43-44	3.79	.80	.45	.99	.18	2.43
1944-45 to 48-49	5.39	1.38	.69	1.42	.24	3.72
1949-50 to 51-52	6.11	1.29	.75	1.59	.30	3.92

Source: Sunkist Growers, Inc. Statistical Information on the Citrus Fruit Industry. 1951. Supplement, 1953. Table 11.

Table 6

Relative changes in f.o.b. prices, cultural and marketing costs: Lemons
(1934-35 to 1938-39 = 100)

Cultural year	Weighted f.o.b. prices	Cultural costs	Picking & hauling costs	Packing costs	Selling & advertising costs	Total four cost items
1924-25	129	143	124	116	94	128
25-26	93	102	127	110	82	107
26-27	113	89	108	112	88	100
27-28	137	151	122	106	112	129
28-29	132	106	122	106	94	108
1929-30	145	163	116	106	112	133
30-31	113	96	119	105	100	103
31-32	103	92	105	104	106	99
32-33	97	96	92	94	100	95
33-34	103	89	95	91	100	92
1934-35	83	60	87	98	94	79
35-36	120	116	97	96	100	105
36-37	127	139	105	106	106	120
37-38	86	106	108	100	94	103
38-39	82	83	100	101	106	93
1939-40	86	90	97	100	100	95
40-41	83	39	92	106	106	75
41-42	93	74	108	126	106	99
42-43	132	92	149	139	112	108
43-44	145	110	165	150	118	132
1944-45	134	109	181	155	118	136
45-46	125	113	170	165	135	141
46-47	153	130	181	176	141	154
47-48	156	128	192	191	147	161
48-49	200	187	200	199	159	191
1949-50	171	127	197	194	165	162
50-51	166	120	200	200	182	160
51-52	183	135	211	202	176	172

Source: Calculated from data in Table 5.

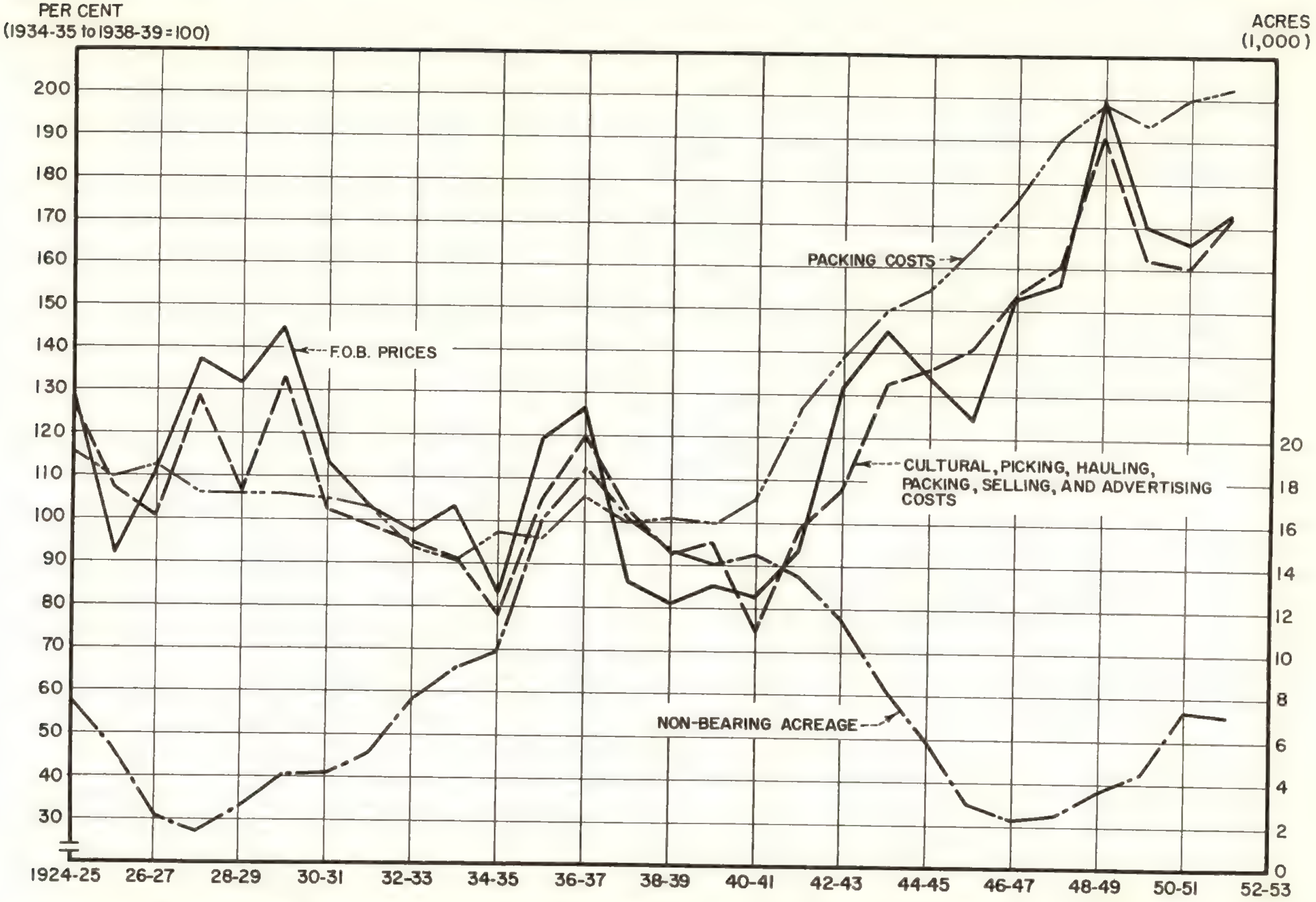

FIGURE 6. RELATIVE CHANGES IN LEMON F.O.B. PRICES, IN PACKING COSTS, AND IN CULTURAL, PICKING, RACKING, HAULING, SELLING, AND ADVERTISING COSTS; COMPARED WITH NON-BEARING ACREAGE.

SOURCE: TABLE 6.

Of special importance from the standpoint of this study is the fact that, since the base period (1934-35 to 1938-39), packing costs have risen more or less consistently and to a greater extent than have f.o.b. prices. In other words packing costs are tending to absorb a larger proportion of f.o.b. prices than they did in earlier years,

These data on relative f.o.b. price and cost changes tend to present a somewhat more favorable picture for recent years of net returns to producers than was actually the case. Between 1924-25 and 1938-39, about 80 per cent of all lemons was shipped as fresh fruit (see Figure 3) whereas since 1939-40 less than 70 per cent of fruit was shipped fresh. Prices received by growers are a blend of prices on fresh fruit and prices of fruit shipped to by-products plants. As returns (per packed box equivalent) on fruit sold for by-products uses are considerably below those obtained for fruit sold fresh, the relative net blended prices received by farmers would not have risen since the base period to the same extent as fresh fruit prices.

Further light on the relative profitability of lemon production is afforded by estimates made annually by the California Citrus League relative to the on-tree farm value, cultural costs, and net income (before allowing for interest on investment and depreciation on trees) per acre. These data (Table 7) indicate that net income per acre in dollars fluctuates widely from year to year but during the period 1924-25 to 1943-1944 showed a moderate upward trend. During the 5-year period 1924-25 to 1928-29, net income per acre averaged $75 as compared with $128 during the period 1939-40 to 1943-44. During the next 5-year period, net income per acre averaged only $49 but increased appreciably to an average of $208 during the 3 years, 1949-1950 to 1950-51.

These data are in absolute terms. If the wholesale commodity index (1935-1939 = 100) is used as a measure of the buying power of the dollar, the adjusted average annual net income per acre of lemons rose sharply during the first 15 years (1924-25 to 1938-39), declined moderately during the next 5-year period (the war years), and fell sharply during the postwar period to 1948-49. During the last 3-year period (1949-50 to 1951-52), adjusted annual net farm income averaged $97. While this figure was over 3 times greater than for the preceding 5-year period, it was still substantially less than the average for the 15-year period 1929-30 to 1943-44.

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Table 7

On-tree farm value, cultural costs and income per acre: Lemons 1924-25 to 1951-52

Year	On-tree value per acre (dollars)	Cultural costs per acre (dollars)	Income before interest on investment & depreciation of trees (dollars)	Index of wholesale prices (1935-39 =100)	Income divided by index of wholesale prices
1924-25	334	272	62	128	48
25-26	252	257	- 5	124	- 6
26-27	289	248	41	118	35
27-28	398	281	117	120	97
28-29	451	294	157	118	133
1929-30	489	309	180	107	168
30-31	359	278	81	91	89
31-32	280	243	37	80	46
32-33	302	207	95	82	116
33-34	386	224	162	93	174
1934-35	312	216	96	99	97
35-36	542	244	298	100	298
36-37	487	322	165	107	154
37-38	295	245	50	98	51
38-39	249	235	14	96	15
1939-40	283	225	58	98	59
40-41	266	186	80	108	74
41-42	253	201	52	123	42
42-43	464	219	245	128	191
43-44	471	266	205	129	159
1944-45	408	296	112	131	85
45-46	289	334	- 45	150	- 67
46-47	414	355	59	189	31
47-48	371	359	12	205	6
48-49	532	428	104	192	54
1949-50	558	362	196	200	98
50-51	515	355	160	224	71
51-52	628	360	268	218	123
Averages					
1924-25 to 28-29	345	270	75	122	61
1929-30 to 33-34	363	252	111	91	122
1934-35 to 38-39	377	252	125	100	125
1939-40 to 43-44	347	219	128	117	109
1944-45 to 48-49	403	354	49	173	28
1949-50 to 51-52	567	359	208	214	97

Source: Sunkist Growers, Inc. Statistical Information on the Citrus Fruit Industry, 1951. Supplement, 1953. Table 12.

In many of the counties in southern California, there are large numbers of lemon groves which are yielding less than 300 field boxes per acre.[10] Enterprise efficiency studies made by the Agricultural Extension Service indicate that under the price-cost conditions that have existed during recent years a yield of less than 300 boxes of lemons per acre will not result in farm returns sufficient to cover cultural and management costs.

One may infor from these statistics and estimates that except for the more fortunate areas lemon growing has not been particularly profitable since World War II. In some areas and in many individual orchards it has been unprofitable.

One further question needs to be answered. Is it not possible that there will be reduced supplies of lemons and that prices of fresh fruit will rise? Within recent years there has been a considerable expansion in the production and consumption of canned and frozen citrus fruit and other fruit juices. A recent study indicates that, although sufficient data are not yet available to test the demand interrelations between fresh and processed lemon juices, market information generally indicates that the two products do evidence some competitive demand relation.[11] It is probable that the increasing popularity of canned citrus juices will act as a damper on any marked increase in prices of fresh lemons.

In this connection it may well be pointed out that the consumption of lemons is greatly influenced by changes in weather. A spell of warm weather will cause a marked rise in consumer purchases of lemons. It normally takes from 8-12 days to ship lemons from California to eastern markets. Because of this, it is extremely difficult to regulate the flow of fruit to market so as to take advantage of short spells of warm weather. Considerable spoilage of fruit may occur if increased shipments in response to a spell of warm weather may arrive at eastern markets when a spell of cooler weather sets in. Any-

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[10] Tinley and Parks, op. cit. This study of the Ontario-Cucamonga area of San Bernardino County showed that about 46 per cent of the lemon groves, representing 37 per cent of the acreage in the area, had yields of less than 300 field boxes per acre.

[11] Hoos, Sidney and Seltzer, R. E. Lemons and Lemon Products, Changing Economic Relationships, 1951-52. Berkeley, 1952, p. 6. (California Agricultural Experiment Station Bulletin No. 729).

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[11] [illegible]

thing that can be done to gauge weather changes more accurately or to maintain better insulation of fruit upon arrival at consumers' markets would help to reduce loss through spoilage.[12] As matters have stood, however, lemon growers' incomes have been highly dependent on the vagaries of weather in the Eastern United States.

Methods of Handling Lemons in Packing Houses

Introduction.--In the preceding section were presented briefly some of the economic trends affecting the lemon industry. There is evidence that the economic status of growers of lemons has deteriorated during recent years except perhaps in Santa Barbara and Ventura counties in which a large number of orchards have been planted in recent years. An important element in the production and marketing of lemons is the cost of packing fruit. These costs have risen sharply and continously since 1940-41 and in the absence of radical changes in packing techniques were likely to have risen still further. During the last few years, packing costs have absorbed about 25 per cent of the f.o.b. prices obtained by packing houses for fresh fruit sales. Any economies that may accrue from reduction of packing costs would prove of considerable benefit to growers.

An understanding of the potential savings that may be made by packing houses in handling lemons in cartons rather than in the customary wooden box will be facilitated by a brief description of the changes in operating techniques involved and of the new types of equipment utilized. It should be stressed, however, that the adoption of new equipment is still in the "trial and error" stage in most packing houses.

Packing in Standard Wooden Box.--Although there are many minor variations[13] in the methods of handling lemons in packing houses, many of the procedures and much of the equipment used are rather highly standardized. The brief description given below may be regarded as typical for most of the

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[12] The relation of weather to market demand is mentioned at this point because, as will be shown later, the carton appears to have good insulating qualities.

[13] There are variations in equipment and plant layout associated with such factors as volume of fruit handled, location of packing house, capital invested, and so on.

[illegible] Eastern United States.

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[12] There are variations in equipment and plant layout that result from such factors as volume of fruit handled, location of packing house, [illegible], and so on.

lemon packing houses in California.

The great majority of lemon packing houses in California were erected more than 30 years ago,[14] though in many cases, structural and other changes may have been made within recent years. Packing houses require access to good roads for fruit from groves and to railroad facilities for packed fruit loaded into cars. The minimum essential equipment required would include a dump, a fruit washer, a trash eliminator, a soaking tank, a boxmaker, a lidder, and hand trucks, plus conveyor, sorting and packing belts together with the necessary electric power equipment and heating units. Each house would have fruit storage rooms where fruit can be maintained at desirable temperature and humidity and storage space for shook, packing and other materials.

Field boxes of fruit received from groves by truck are unloaded at a receiving platform usually by hand truck. Each grower's fruit is stacked separately in an area adjacent to the receiving platform. When the fruit is ready for washing, the field boxes are emptied into a dump where trash is removed. It is then soaked for a couple of minutes, scrubbed and often waxed. Some sizing usually occurs--at least enough to eliminate lemonettes (fruit so small as to be seldom fit for shipping as fresh fruit). Such fruit is usually shipped to products plants. Many packing houses, however, have sizers at the washer for sorting fruit into several size groups. In cooperative houses samples are usually taken of each grower's fruit at this stage, the sample, sorted by size and quality (and sometimes by color), being used as the basis of settlement with each grower. Fruit from the washer or sizer is passed along a sorting belt where culled fruit (fruit with blemishes or otherwise unsuitable for fresh shipment) is removed and conveyed to cull bins. The good fruit is manually sorted into several color categories and placed in storage boxes and conveyed to storage rooms.

Fruit may be kept in storage at controlled temperatures and humidity any time from a week or two to several months, depending upon stage of maturity at time of picking. When fruit has reached the desirable color for packing and the market demand is deemed to justify shipment, it is taken to the packing area where the fruit is dumped on a belt for sorting. Decayed and otherwise unsuitable fruit is removed and from there the fruit moves up the packing equipment.

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[14] In Ventura and Santa Barbara counties, many packing houses were erected within tha past 20 years.

In periods of short supply the coloring process may be accelerated by placing the fruit in smaller rooms at somewhat higher temperatures and applying ethylene gas. The fruit may thus be ready for shipment in less than a week's time.

One of two methods of packing fruit may be used. Under the first method, fruit will be run onto a continuous packing belt on both sides of which are packers (usually women) spaced at intervals. Each packer will remove from the belt fruit of a single size, wrap each fruit separately, and place it tightly in a packing box. A specific pattern is used for each fruit size which gives a uniform and distinguishing count number for each size. This size-count relationship is established and maintained by state law. Such packers are usually paid on the basis of 1,000 fruit packed. Each packer stamps on a box her number and the size of the fruit packed. A record is kept of the number of boxes packed by each packer. The fully packed box is then pushed onto a conveyor belt and passed onto an automatic lidder. After lidding, the fruit is stacked by size and is ready for loading into railroad cars. Loading is usually done by specially trained men in order to insure proper stacking of boxes.

The second type of equipment is a draper type of sizer which sorts the fruit by diameter but in a very ununiform fashion. Revolving bins hold the fruit thus sized and packers can select their fruit a little easier. Otherwise, the two methods are identical.

Two aspects of the packing of fruit in standard boxes require special mention, construction and use of the box and the training of packers. Box shook, nails, wrappers, labels and other packing supplies are ordered by houses in bulk (usually carload lots) whenever needed. Upon receipt at the packing house, such supplies are unloaded and conveyed for storage in a specially reserved area of the house. As boxes are needed for storage, the shook is fed into an automatic boxmaking machine. The boxes (without lids) are then placed upon conveyor belts and are filled with fruit going into storage. These boxes are usually used twice, first for storage of fruit and later as packing boxes. As fruit out of storage is dumped, boxes are placed on conveyor belts for cleaning. Some of the boxes are then conveyed to the packing area; others are again filled with newly received fruit for storage. For some years back about one half of the boves from storage have been returned to storage with new fruit. The box for storage is very loosely filled

[illegible]

One of two methods of packing fruit may be used. Under the first method, fruit will be run onto a continuous packing belt on both sides of which are stations (usually women) spaced at intervals. Each packer will remove from the belt fruit of a single size, wrap each fruit separately, and place it [illegible] in a packing box. A specific pattern is used for each fruit size which gives a uniform and distinguishing count number for each size. This [illegible]. The packers are usually paid on the basis of 1,000 fruit packed. Each packer stamps on a box her number and the size of the fruit packed. A record is kept of the number of boxes packed by each packer. The fully packed box is then pushed onto a conveyor belt and passed onto an automatic lidder. After lidding, the fruit is stored by size and is ready for loading into railroad cars. Loading is usually done by very highly trained men in order to insure proper stacking of boxes.

The second type of equipment is a drop or tree of stand which sorts the fruit by diameter but in a very uniform fashion. Revolving bins hold the fruit that is sized and packers can select their fruit a little easier. Otherwise, the two methods are identical.

The aspects of the packing of fruit in standard boxes require special [illegible], construction and use of the box and the training of packers. Box [illegible] [illegible] in bins (usually cooled lots) [illegible] months. Upon receipt at the packing house, such supplies are unloaded and conveyed for storage in a specially reserved area of the house. As boxes are needed for storage, the [illegible] is fed into an automatic boxmaking machine. The boxes (without lids) are then placed upon conveyor belts and are filled with fruit going into storage. These boxes are usually used twice, first for storage of fruit and later at packing house. As fruit out of storage is dumped, boxes are placed upon belts for cleaning. Some of the boxes are then conveyed to the [illegible] For some years back about one half of the boxes from storage have been returned to storage with new fruit. The box for storage is [illegible] so as to hold only about two thirds of that when packed. As pointed out elsewhere about one third of the fruit is not packed anyway. Also, some low-grade fruit is sorted out.

The sizing, handwrapping, and place packing of lemons in standard boxes require a long period of training before a new packer acquires reasonable speed and dexterity. In many packing houses some women are employed primarily to train new packers. The latter are often paid on an hourly basis, whereas most trained packers are paid on the basis of number of fruit packed. The training of new packers is regarded as a necessary packing expense. Estimates obtained from packing house managers indicate that the cost of training new packers may vary from about 1 cent to as much as 5 cents a packed box of lemons, depending upon the size of packing house, the average wage rate, and the rapidity of turnover of packers.

If a large number of new packers were being trained at a time, the whole flow of fruit through a plant may be slowed down for several weeks. This interference with normal operations would not be serious if only a few packer trainees were interspersed among a number of experienced packers. Another important factor that would influence the per-box cost is the rate of turnover. If packers once trained would continue at a plant for several years, the initial cost would be spread out over a large volume of fruit and the cost per box would be small. If, on the other hand, there is a fairly high rate of turnover of packers, the cost per box would be great. Within recent years packing houses, especially in some areas, have experienced considerable difficulty in getting and keeping packing house labor. As a result, it is probable that the cost per box of training new packers has increased, quite apart from increases in wages.

The shortage of trained packers presents an acute problem during periods of peak shipments. It is often necessary for packing houses to turn down attractive offers for fruit because shortage of packers makes it impossible to pack additional cars of fruit.

Packing in Cartons.--Up to date the packing of fruit in cartons has involved no important changes in the methods of handling fruit up to the end of the storage operation. Fruit is still received, washed, color sorted, and moved into storage as before. The standard packing box is still used for storage although research and experiments are under way to devise a more satisfactory storage box. The most fundamental changes are in the actual

packing operations which require new internal plant arrangements and various types of new equipment. Some minor changes are also being made in the methods of loading railroad cars. All packing houses still have their equipment for packing fruit in standard boxes which are still used for export although experimental export shipments in cartons have been made. In most houses, additional space had to be provided for such new equipment and conveyor belts as were needed to pack fruit in cartons. In one or two houses, attempts were made to adapt the packing belts so that the same belts could be used for packing in both standard boxes and cartons. In all houses, additional space near the packing area had to be provided for the storage of cartons.

Two methods of packing lemons in cartons have been used in California since the introduction of this new container. The first is known as the "place pack" method in which fruit of uniform size is placed manually into cartons. The second is known as the "volume fill" method in which fruit of uniform size is poured into a box from a conveyor belt. The latter method appears to have become increasingly popular recently. Several houses contacted during the course of this study had gone over 100 per cent to the volume-fill method. These two methods have important differences in labor and equipment requirements. Under the place-pack method it is possible to use much the same packing belts (with perhaps minor adaptations) or bins as are used for packing fruit in the standard wooden box. Although fruit in the place-pack method is not wrapped, only a moderate reduction in actual packing labor has been achieved in commercial operation, whereas a considerable reduction has been obtained under the volume-fill method.15/

The place-pack method requires no special changes in equipment from that used in packing fruit in standard boxes, except perhaps an automatic glue sealer for sealing filled cartons.

15/ A new and extremely fast motion packing technique was worked out for the naked pack in the new carton but was never put into use. It required special conveyors for fruit and seat equipment for packers and was overshadowed by the greater cost reductions and simpler training requirements of the volume-fill technique.

See: Roy J. Smith. "A Time and Motion Study in Packing Lemons." California Citrograph, vol. 37, no. 7, May 1952, p. 275.

Roy J. Smith. Memorandum on Proposed Packing System. To Ventura County Citrus Growers Committee, Santa Paula, California. January 5, 1949. Ditto. 5p.

[illegible] rations which require new internal plant arrangements and various [illegible] equipment. Some other changes are also being made in the [illegible] 1949 [illegible] ment for packing fruit in standard boxes which are still used for export although experimental export shipments in cartons have been made. In most houses, additional space had to be provided for such new equipment and conveyor belts as were needed to pack fruit in cartons. In one or two houses, alterations were made to adapt the packing belts so that the same belts could be used for packing in both standard boxes and cartons. In all houses, additional space near the packing area had to be provided for the storage of cartons.

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See: Roy J. Smith. "A Time and Motion Study in Packing Lemons." [illegible] Citrograph, vol. 37, no. 7, May 1952, p. [illegible]

Roy J. Smith. Observations on Proposed Packing Systems. Ventura County Citrus Growers Committee, Santa Paula, California. January 5, 1952. Ditto. 5p.

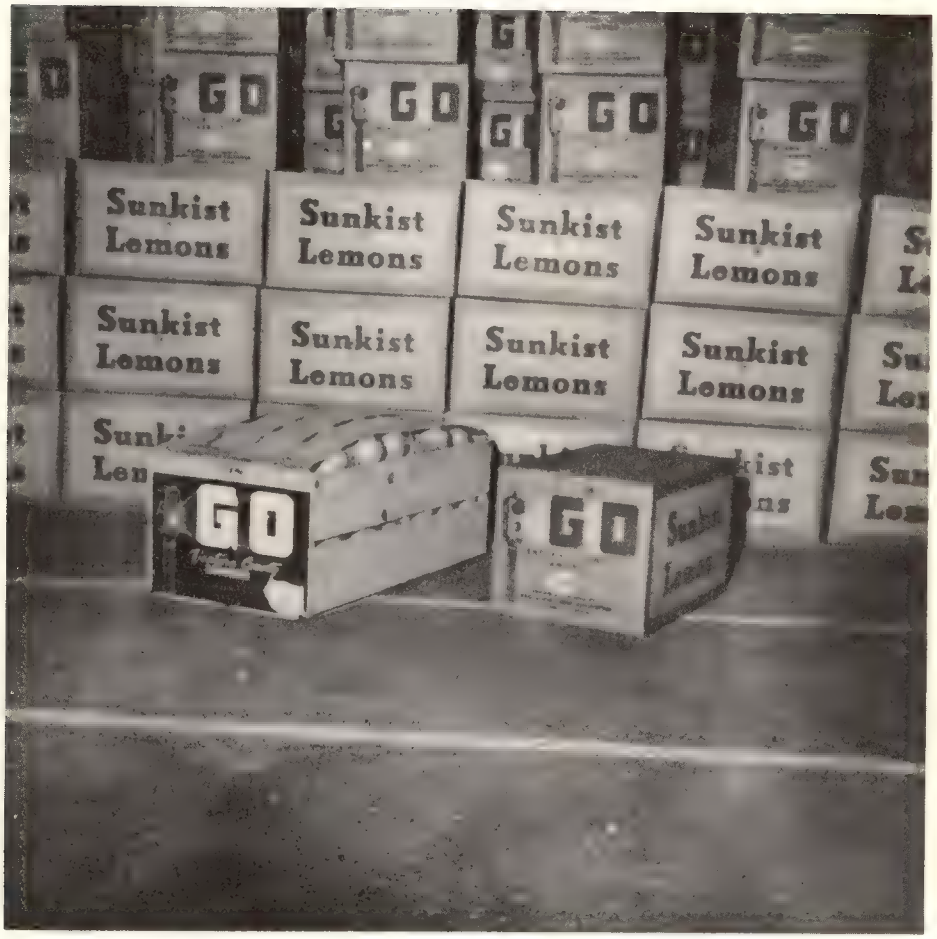

Figure 7

Old and new lemon containers. New carton contains exactly one-half as many lemons as old. Average weight of old was 86 pounds, of new about 41 pounds. Within two years of original shipment, 80 per cent of lemon shipments had been changed over to new carton.

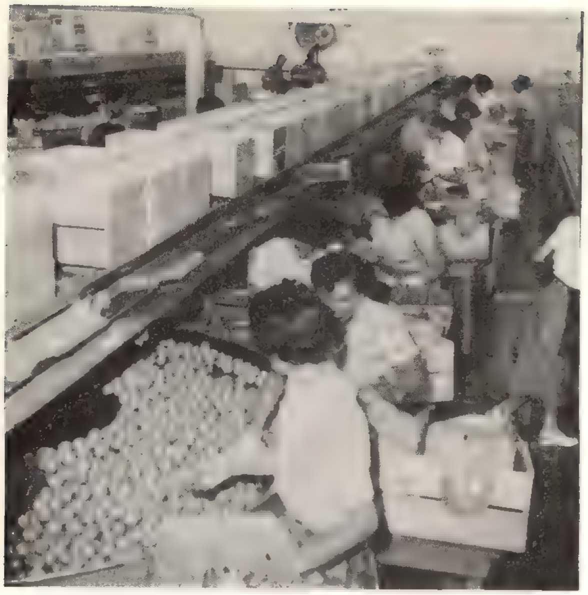

Figure 8

Old wrap pack packing line with rotating bins. Empty boxes on rack at left. Girl at right is shunting packed box to conveyor.

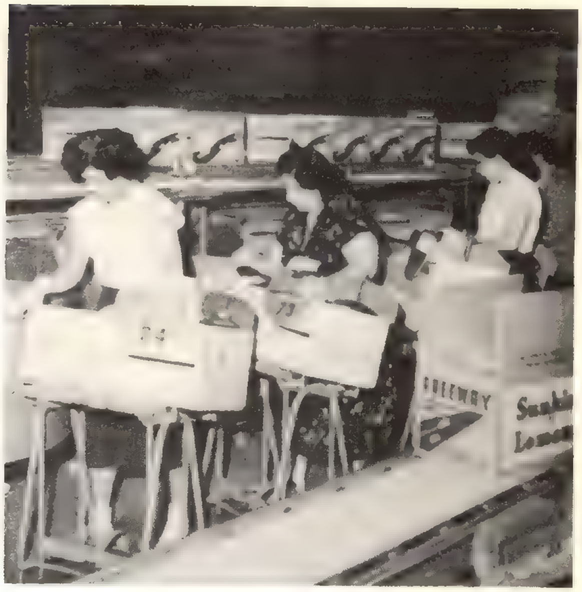

Figure 9

Packers at stations with rotating bins. Note crowded quarters. Average girl could wrap pack about 12,500 fruit in 8 hours. New box on conveyor at lower right shows house is converting to new box.

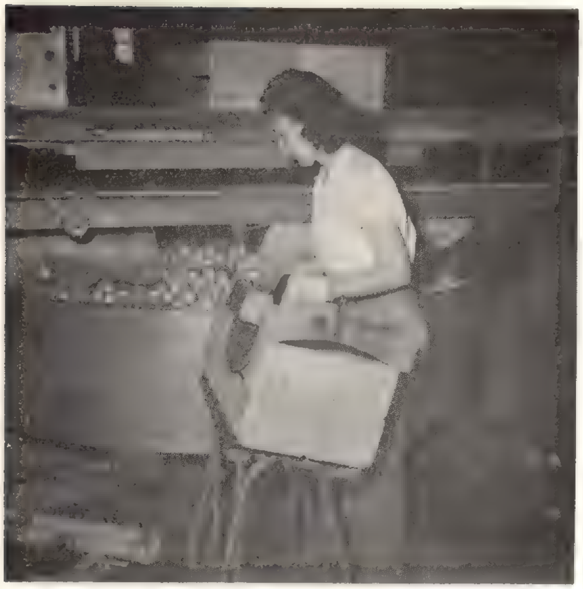

Figure 10

Typical packing posture of old wrap pack system. Note stoop and concentration.

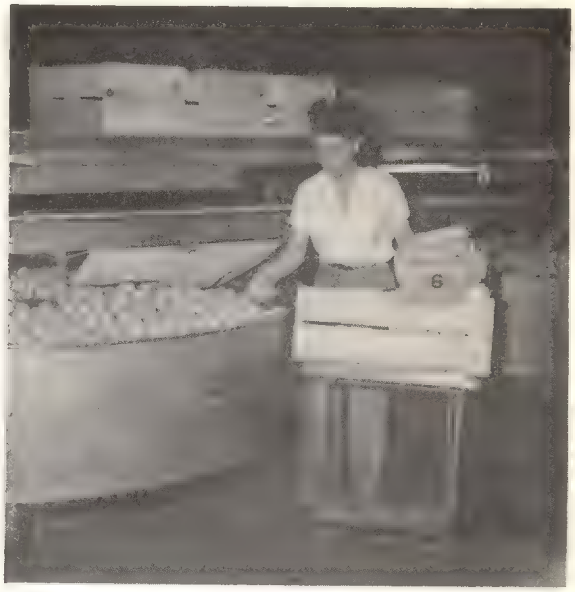

Figure 11

Front view of girl on old wrap pack. Eyes on fruit in rotating bin picking out lemons of proper size. Right hand picks up fruit while left hand pulls off wrap from stand at left.

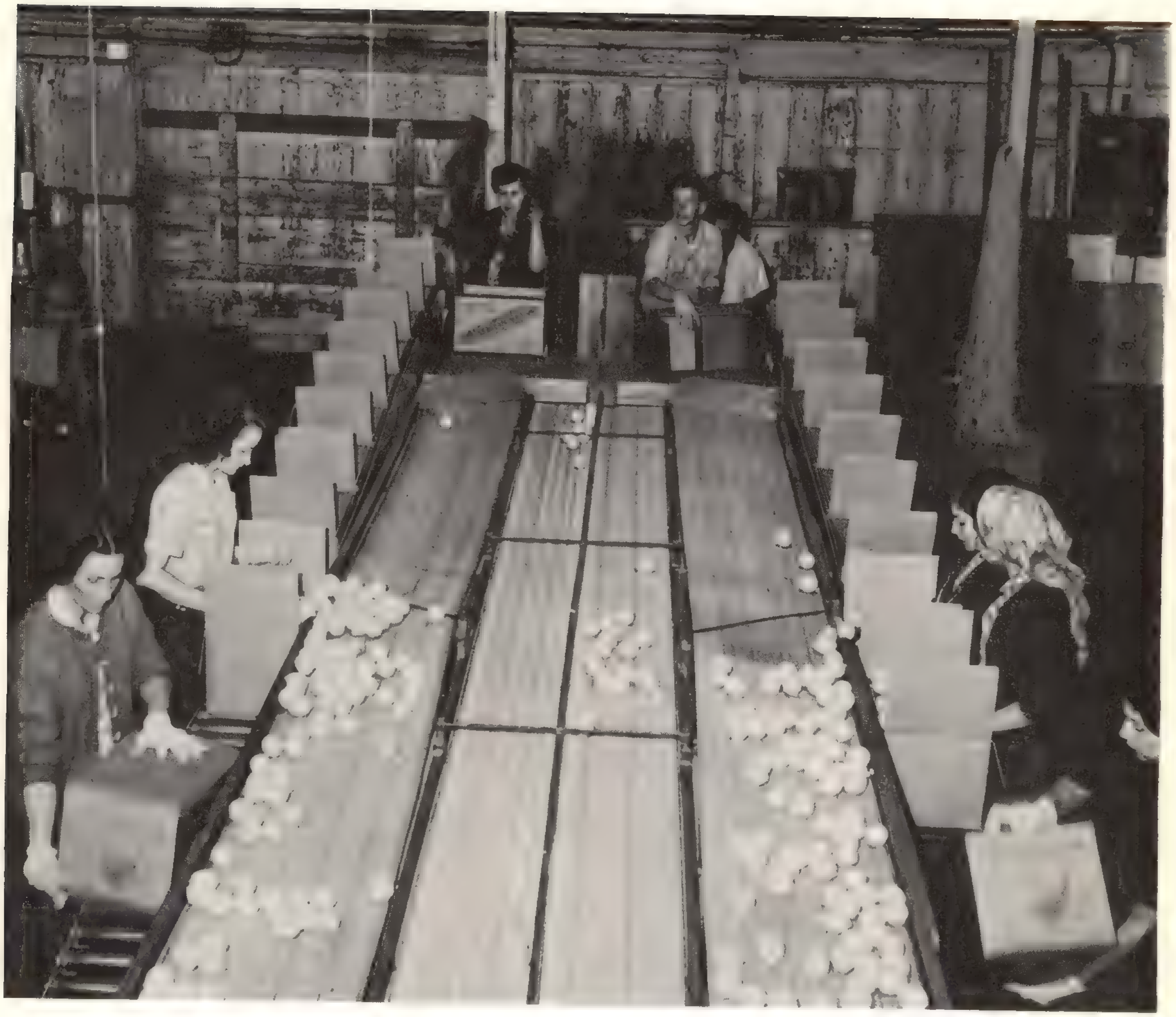

Figure 12

Volume Fill, simplest method, in operation. Two sizes of fruit shown, one on each side. Fruit flows into boxes which when full are rolled on to next girls who are shown turning them over so as to settle fruit. People at back are shown folding boxes which they set into shoots. Eleven girls with this equipment in first week of run easily did work which would have required about 50 with old wrap pack.

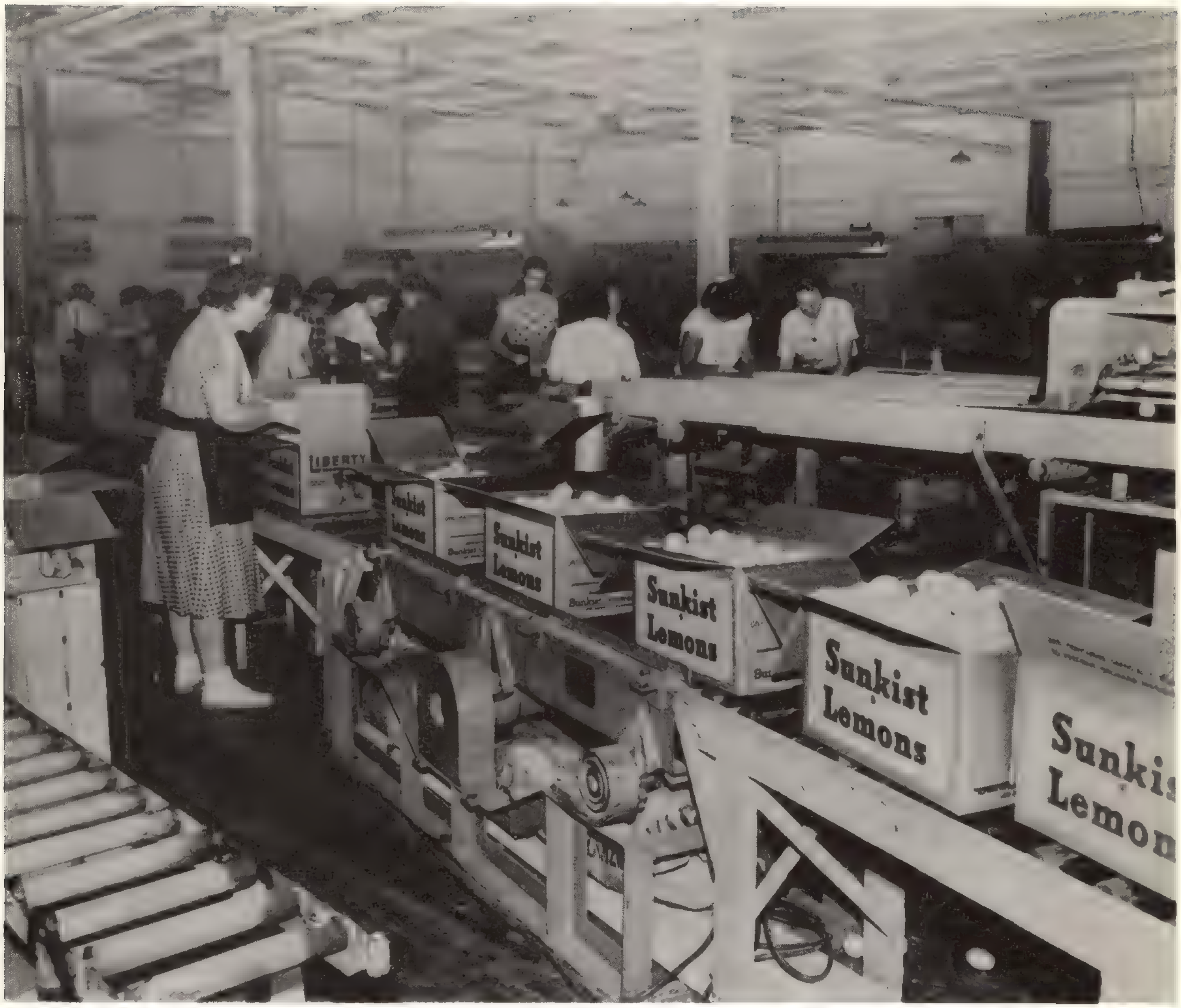

Figure 13

Experimental fruit shaker in operation. It is used in all but simplest of volume fill systems. Boxes move from right to left. Note how fruit settles. All had been given same approximate fill. Woman at left makes sure of level fill by adding or taking off fruit as needed after settling. Carton is then ready for sealing.

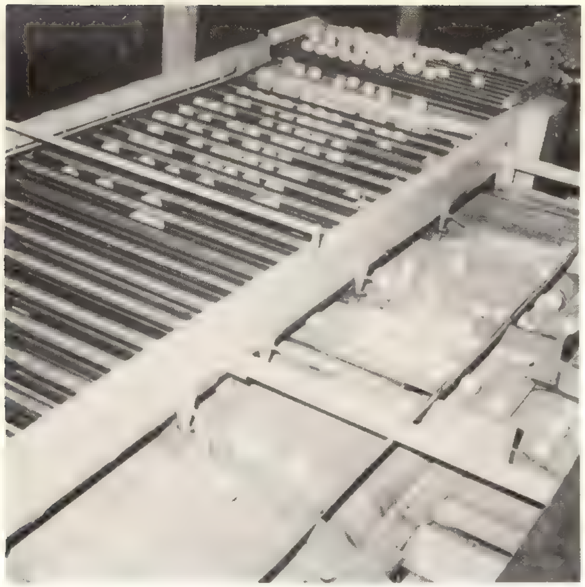

Figure 14

Automatic sizer in operation. Fruit flows from right to left. Rollers spread apart and let fruit fall through, small fruit first. Sized fruit carried out by belts, lower right.

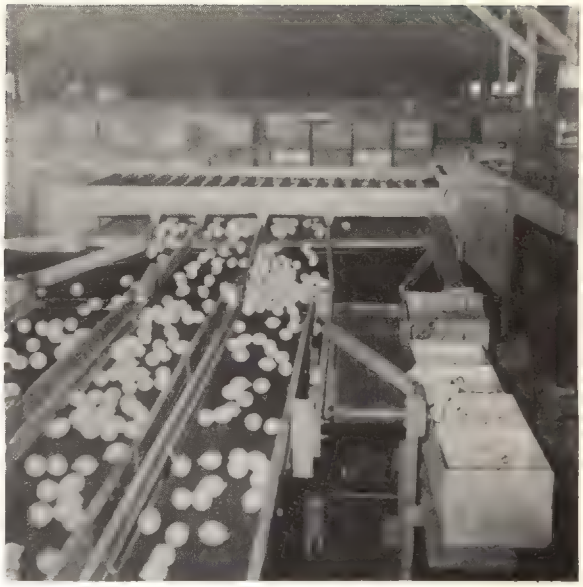

Figure 15

Sized fruit being carried from sizer to volume fill belts. Right hand belt with only one fruit handles a size too small for profitable packing and so is automatically shunted to boxes to sell in bulk for juice.

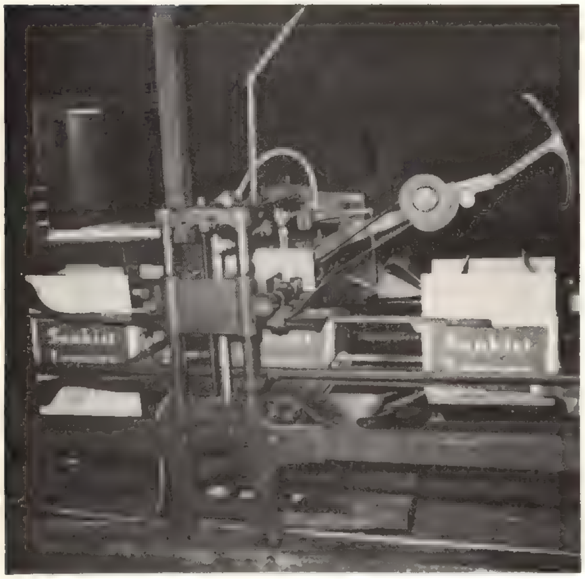

Figure 16

Sealing machine in operation. Top and bottom flaps are opened, glued and then pressed shut. Fully automatic.

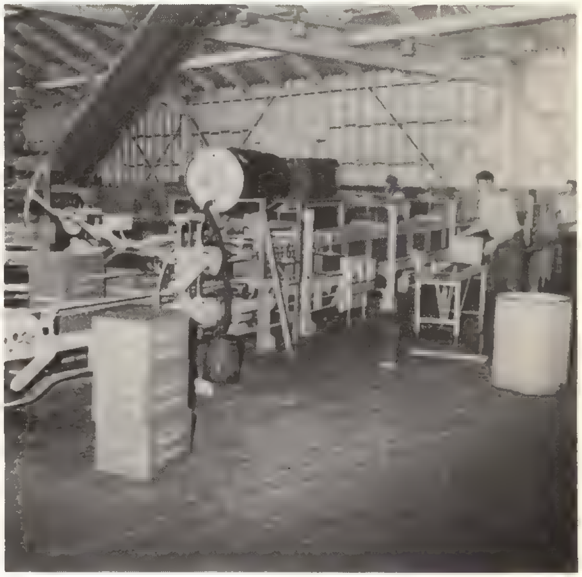

Figure 17

General view of sealer. Cartons enter from left. Tank on top holds large reserve of glue. To conserve space sealed boxes are turned back to conveyor on right from which they are set off and stacked by size.

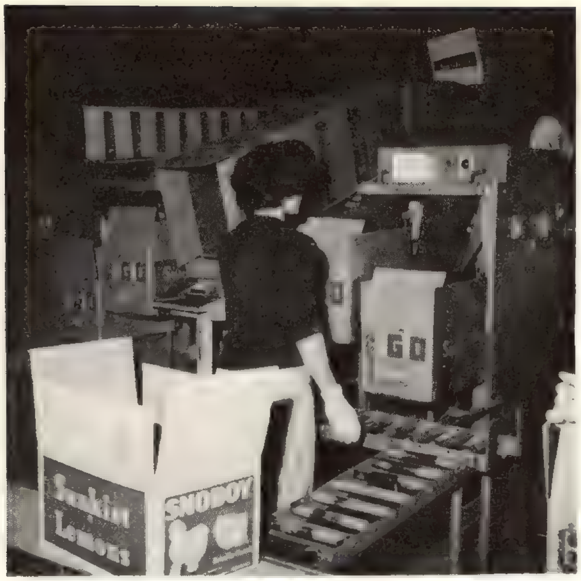

Figure 18

Semi-automatic carton filler in operation. When carton is approximately filled flow of fruit is automatically shunted to other carton. Girl then rolls filled box to conveyor, lower left and replaces with empty carton.

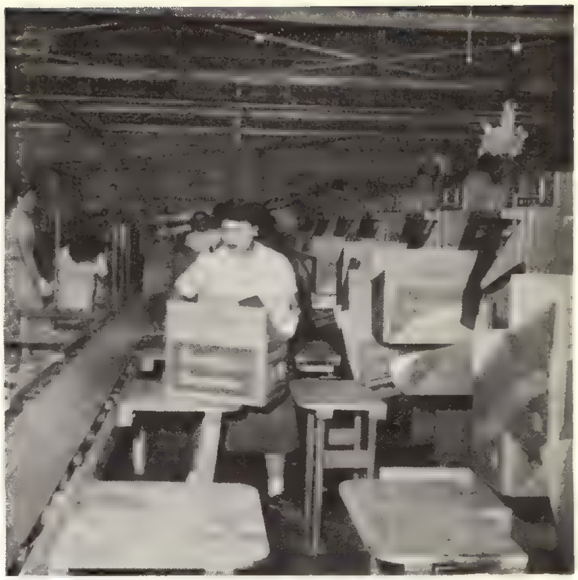

Figure 19

General view of semi-automatic box fillers. Waxed boards substituted for rollers shown in Figure 18. Girl is shifting filled box to conveyor.

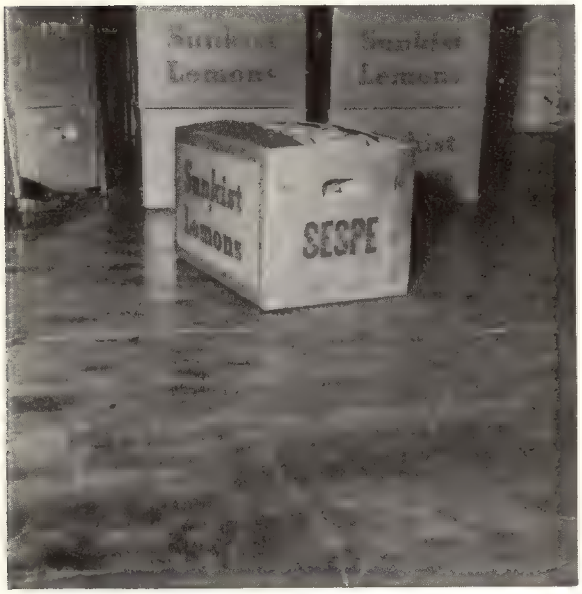

Figure 20

First experimental box for local shipments. No sealer required. Open top to permit air movement. Top layer wrapped.

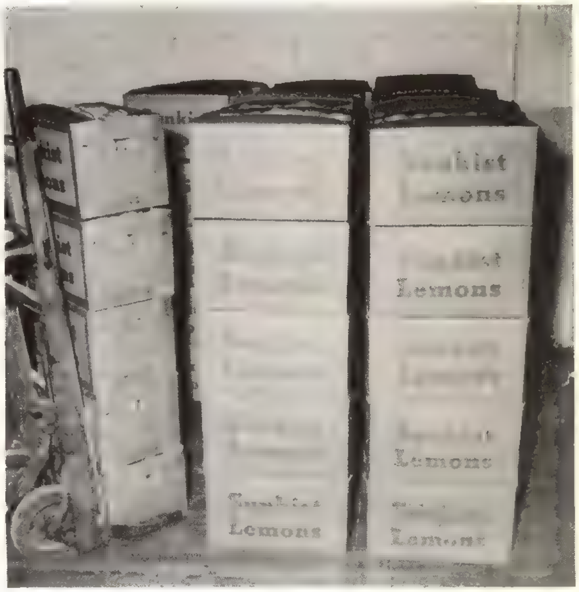

Figure 21

Experimental boxes stacked. Hand truck shown at left.

Great variations were observed in individual packing houses in the types of additional equipment installed to handle fruit by the volume-fill method. Equally great variations were observed in plant layout. Although many houses had gone over 100 per cent to the volume-fill method, they, as well as other houses still using the place-pack or standard box, appeared to be still in the "shakedown" stage. Internal plant arrangement of equipment and packers was being changed from time to time. In some houses newly installed equipment did not appear to be working too satisfactorily. Modifications were being made. Some of the new equipment has been replaced already.

The minimum new equipment for volume fill is a mechanical sizer and a few additional conveyor belts and simple equipment for stitching of cartons. This is as far as a few small houses with low volume of fruit have gone. The larger packing houses, however, have installed some or all of the following types of new equipment (in addition to conveyor belts): a vibrator or shaker for settling fruit in cartons, an automatic glue carton sealer, semiautomatic or automatic carton fillers (installed in only a few houses), pallets on which packed cartons can be stacked, and small power trucks for loading pallets of cartoned fruit into railroad cars.

During the course of this study four methods of volume filling were observed. All required the use of a mechanical sizer. The simplest method involves the use of what packing houses call a "sheerboard" by means of which fruit is diverted or shunted off a conveyor belt into cartons. After the carton is filled, an operator closes the flaps and turns the carton over in order to settle the fruit. The carton is then conveyed to an automatic sealer. The packers must estimate the fill before closing the flaps.

The second and more common method is to fill boxes as in the first method. The fruit is then conveyed over a mechanical vibrator or shaker which settles the fruit in a solid fill. An inspector adds or subtracts fruit and dresses the top to level the fruit for sealing. Additional equipment needed under this method is the mechanical vibrator.

The third method is the use of a battery of semiautomatic filling machines, each with two pans on which cartons are placed by hand. The fill of fruit is controlled by weight. As a carton reaches the approximate weight, the flow of fruit is stopped and automatically transferred to the next carton on the adjacent pan. The packer transfers the filled cartons to another conveyor belt where it is passed over the vibrator, inspected, and then sealed.

The weight used in controlling the approximate fill is adjusted to each of the various types of fruit so that a full dry measure is always attained.

Under the fourth method a fully automatic battery of carton fillers is planned. Empty boxes will be fed in, filled and sent on to the vibrator mechanically.[16]

Cartons, already stapled by the manufacturer, are received in bulk, usually in carlots, and are stacked in flat bundles near in the packing area. In all houses visited, bundles of cartons and collars were trucked to employees (usually one or two) who shaped the cartons by a few simple movements and inserted a collar, if used. The shaped cartons were then placed on a conveyor belt or on a chute from where they were removed by a packer or automatically where the automatic equipment was used. It is understood that experiments are underway for the development of an automatic boxforming machine.

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[16] Some further details on these packaging methods will be found as follows:

Roy J. Smith. "New Lemon Boxes". California Citrograph, vol. 36, no. 11. September, 1951. p. 438.

_____________ "Modern Lemon Packaging". Good Packaging, June 1952. pp. 17-19.

_____________ "Volume Fill for Citrus Fruit". California Citrograph, vol. 37, no. 12. October, 1952. pp. 462-477.

_____________ "New Low-Cost Packing System for Citrus Fruit is Developed". Citrus Leaves, vol. 32, no. 11. November, 1952. pp. 6-9.

_____________ Memorandum on "Volume Fill". To Citrus Industry Research Association, Santa Paula, California. April 28, 1952. Ditto. 2pp. (Department of Agricultural Economics, University of California)

_____________ Memorandum on Standardizing the "Volume Fill". To Citrus Industry Research Association, Santa Paula, California. July 11, 1952. (Revised). Ditto. 3pp. (Department of Agricultural Economics, University of California)

_____________ Memorandum on Recommendation concerning Count Requirements in the Volume Fill for Lemons. August 6, 1952. (Tables attached dated July 25, 1952). Mimeographed. Various paging. (Department of Agricultural Economics, University of California)

_____________ Memorandum on Suggested Inspection System for Proper Fill of One-Half Box Carton. To Citrus Industry Research Association, September 18, 1952. Ditto. 2pp. (Department of Agricultural Economics, University of California)

_____________ Memorandum on Volume Fill Problems. To Citrus Industry Research Association. November 10, 1952. Ditto. 4pp. (Department of Agricultural Economics, University of California)

The weight used in controlling the approximate fill is adjusted to each of the various types of fruit so that a full dry measure is always attained.

Under the fourth method a fully automatic battery of carton fillers is planned. Eight boxes will be [illegible], filled and sent on to the vibrator [illegible].

Cartons, already shaped by the manufacturer, are received in bulk, [illegible] barrels, and are stacked in that building next to the packing area. In all houses visited, bundles of cartons and collars were turned to employees (usually one or two) who shaped the cartons by a few simple movements and inserted a collar, if used. The shaped cartons were then placed on a chute or belt or in a chute from where they were removed by a packer or automatically where the automatic equipment was used. It is understood that experiments are underway for the development of an automatic box-forming machine.

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[1] Some further details on these packaging methods will be found in [illegible]

Fay J. Smith, "The Lemon Boxes", California Citrograph, vol. 26, no. 11, September, 1941, p. 333.

______. [illegible], California Citrograph, [illegible]

______. [illegible], California Citrograph, vol. 27, no. 12, October, 1942, pp. 462-477.

______. [illegible], vol. [illegible], no. 11, [illegible]

______. Memorandum on "Volume Fill" To Citrus Industry Research [illegible], [illegible], California, [illegible] (Department of Agricultural Economics, University of California)

______. Memorandum on Standardizing the "Volume Fill" To Citrus Industry Research Association, Santa Paula, California. July [illegible], 1952. [illegible] Ditto. 3pp. (Department of Agricultural Economics, University of California)

______. Memorandum on Recommendation concerning Craft Requirements [illegible] Fill [illegible]. August 6, 1952. [illegible] (Department of Agricultural Economics, University of California)

______. Memorandum on Suggested Inspection System for [illegible] of [illegible] To Citrus Industry [illegible] Association, September 15, 1952. [illegible] (Department of Agricultural Economics, University of California)

______. Memorandum on Volume Fill Problems. To Citrus Industry [illegible] (Department of Agricultural Economics, University of California)

Advantages.--From an operational standpoint the advantages, already realized or potential, of packing fruit in cartons appear to be:

(a) Some minor reductions in labor inputs with the place-pack method as presently used have been attained.

(b) A considerable reduction in labor inputs with the volume-fill method has been attained.

(c) Unskilled or untrained packers can be used, especially with the volume-fill method.

(d) Less exertion is required of packers in moving full cartons on to conveyor belts and of stackers in stacking sealed cartons.

(e) In some packing houses, especially in some of the smaller and medium-sized houses, somewhat greater flexibility in the use of the labor force appears to be feasible. Because less skill is required of packers, some houses have been able to shift crews around to handle receiving and washing for a few days and then to use them for packing. This should permit more continuous employment of labor.

(f) Greater flexibility appears to be feasible in packing varying volumes of fruit. This should facilitate packing of additional carloads during period of peak shipments.

Disadvantages.--The disadvantages of the new method of packing fruit by volume fill at least at the present stage of transition appear to be:

(a) More floor space is required, or existing packing space is more crowded where equipment is maintained, to permit packing in standard boxes as well as in cartons. If, however, the carton method of packing becomes firmly established, somewhat less floor space would be required.

(b) Much of the older equipment for packing fruit in standard boxes has to be maintained in good operating condition. This involves some additional expense. Moreover, if such equipment has not already been fully depreciated, cartons, for a time at least, would have to bear depreciation on the old as well as on the new equipment.

(c) It is more difficult to maintain a uniform pack by size, shape and weight, especially with the volume-fill method.[17] Many houses do not employ girls for further sorting of fruit by shape.[18] With more experience in volume fill, methods may be developed to overcome this difficulty.

(d) For the time being at least, the cost of storing fruit is likely to be increased. Until a new method is devised for handling fruit in storage, the old standard box (unlidded) will have to be used for this purpose. Estimates of packing house managers indicate that storage boxes should last from 3-5 years depending upon the number of uses annually of each box. Most packing house managers contacted estimated that a storage box could be used from 10-12 times.

Immediate and Potential Reductions in Packing House Costs

Introduction.--In this section will be brought together scattered and preliminary information relative to immediate reductions in costs that may accrue to packing houses by shipping lemons in cartons rather than in standard wooden boxes. Additional potential reductions will be indicated qualitatively because lack of experience in shipping fruit in the new container does not permit quantitative estimates. As about 90 per cent of all lemons produced in California is handled cooperatively, it may be assumed that a large part, if not all, of these cost reductions will, in the short run,[19] be passed back to growers in the form of higher prices for fruit delivered. Information on which the estimates were based was obtained from the Sunkist Growers, Inc., the Fruit Growers Supply Company, the Mutual Orange Distributors, the American Fruit Growers, Inc., and from some 10 packing houses. In addition, a few houses made controlled runs of fruit in different containers in order to determine variations in labor inputs and costs for packing.

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[17] There has been some variation in the fill of cartons. Frequently, management in the anxiety to assure a favorable reception of fruit by the trade has tended to overfill the carton. This was encouraged to some extent by frequent receipt of a premium for cartons with excess weight. Operationally, however, this practice is undersirable as overfilling of cartons makes them difficult to seal and often breaks down the corrugations.

[18] It was stated by informed persons in the trade that there was also some irregularity of shape of fruit wrapped in standard boxes. Because of the wraps, however, these irregularities were not as patent as in the cartons.

[19] The term "short run" will apply to the few years immediately ahead.

(d) It is more difficult to pack in a uniform pack by size, shape and weight, especially with the [illegible] cartons.[17] Many houses do not employ girls for further sorting of fruit by shape.[18] With more experience in this new work, methods may be developed to overcome this difficulty.

(e) [illegible] the [illegible] of [illegible], the cost of [illegible] to be increased, [illegible] the old standard box (unlidded) will have to be used for that purpose. Estimates of packing house managers indicate that storage boxes should last from 3-5 years depending upon the number of uses annually of each box. Participating house managers concerned estimated that a storage box could be used from [illegible].

Immediate and Potential Reductions in Packing House Costs

Introduction.--In this section will be brought together scattered and preliminary information relative to immediate reductions in costs that may accrue to packing houses by shipping lemons in cartons rather than in standard wooden boxes. Additional potential reductions will be indicated qualitatively because lack of experience in shipping fruit in the new container does not permit quantitative estimates. As about 90 per cent of all lemons produced in California is handled cooperatively, it may be assumed that a large part, if not all, of these cost reductions will, in the short run,[19] be passed back to growers in the form of higher prices for fruit delivered. Information on which the estimates were based was obtained from the Sunkist [illegible], Inc., [illegible] Mutual Orange Distributors, the American Fruit Growers, Inc., and from some 10 packing houses. In addition, a few houses made controlled runs of fruit in different containers in order to determine variations in labor inputs and costs for packing.

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[17] There has been some variation in the fill of cartons. Frequently, some fruit, in one capacity to assume a rigorous position of fruit in the space, has tended to overfill the carton. This was corrected to some extent by frequent resort to a practice for cartons with excess weight. Unfortunately, however, this practice is [illegible] as overfilling of cartons makes them difficult to seal and often bulges them [illegible] the corrugations.

[18] It was stated by informed persons in the trade that there was also some irregularity of shape of fruit wrapped in standard boxes. Because of the wrapper, however, these irregularities were not as evident as in the carton.

[19] The term "short run" will apply to the few years immediately ahead.

Experience has shown that the cost of receiving, storing and packing lemons varies greatly between houses depending upon such factors as the volume of fruit handled annually, the percent of capacity utilized, cost of materials and supplies, prevailing wage rates, and size and quality of fruit handled. For these reasons it is desirable to state rather clearly the basic assumptions and practices on which the estimates of cost reductions are based.[20] These are:

(a) Cost comparisons will be in terms of a standard wooden box, two cartons being regarded as the equivalent of the standard.

(b) Packing labor costs will be estimated in terms of fruit of the "360 size".

(c) Although additional cost reductions may eventually be made in other phases of packing house operations, the immediate reductions dealt with in this study will be largely in materials and supplies, freight and packing labor.

(d) In handling lemons in cartons, increased costs will be incurred in storage operations, shape sorting and depreciation which will tend to reduce net reductions.

(e) Freight costs will be estimated on the basis of the so-called "blanket" rate now in force.

(f) Depreciation costs will be based on the costs of new equipment actually installed in a house expecting to handle 200,000 standard units a year.

(g) Because some of the new equipment installed may later be found to be operatively unsuitable, all new equipment will be depreciated over a 5-year period, rather than the customary 10-year period.

(h) Reductions in the cost of materials will be (1) those secured by a group (designated as Group A) of copperative packing houses which together handle about 85 per cent of all lemons grown in California and which purchase their supplies through a cooperatively operated company which owns its own lumber resources and (2) by others (designated as non-Group A) both cooperative and commercial which buy all their supplies from commercial sources.

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[20] Variations of cost reductions where these basic assumptions are not met will be indicated in the text or in appropriate footnotes.

[illegible] varies greatly between houses depending upon such factors as the volume of fruit handled annually, the percent of capacity utilized, cost of materials and supplies, prevailing wage rates, and size and quality of fruit handled. For these reasons it is desirable to state rather clearly the [illegible]s and conditions on which the estimates of cost reduction are [illegible].

(a) [illegible] comparisons will be in terms of [illegible] per box, i.e. [illegible] regarded as the equivalent of the [illegible].

(b) Packing labor costs will be expressed in terms of [illegible]

(c) Although additional cost reductions may eventually be made in other phases of packing house operations, the immediate reductions dealt with in this study will be largely in materials and supplies, freight and packing labor.

(d) In handling items in which, [illegible] costs will be [illegible] not included.

(e) Freight costs will be estimated on the basis of the [illegible]

(f) Depreciation costs will be based on the [illegible] new equipment [illegible] that plant is run [illegible] at least 200,000 boxes of fruit a year.

(g) Because [illegible] of the new equipment installed [illegible] new equipment will be depreciated over a [illegible] year period, rather than [illegible] 6.

(h) Reductions in the cost of materials [illegible] used by a [illegible] about 5 per cent of the [illegible] lumber resources [illegible] by [illegible] and [illegible]

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[1] Variations of [illegible] will be included [illegible] approximately [illegible]

Packing Materials and Supplies.--The costs of the various types of materials used for packing fruit in standard boxes or in cartons were those prevailing during April, 1953. For the purpose of comparability, all supply costs are shown at "billing out" prices and so do not reflect discounts or potential patronage refunds. All Grout A cooperative packing houses purchase their supplies through a single source, the "billing out" prices for boxes and other supplies or for cartons being the same to all houses. The other packing houses, cooperative or independent, purchase their supplies, directly or indirectly, from lumber and other wholesale dealers. In the past the prices paid by these non-Group A houses for shook have varied from 10-15 cents above that paid by the Group A houses. In April, 1953, all houses (Group A and others) were paying the same price for particular types of cartons.

Table 8

Comparative cost of complete standard box and complete cartons: Group A packing houses

Standard wooden box			Two cartons		
Cost item	Cost (dollars)		Cost item	Cost (dollars)	
Materials			Materials		
Box including lid	.470		Cartons with printed labels and impregnated collars	.480	
Nails	.011		Glue	.012	
Straps	.006		Total, material		.492
Paste	.003		Labor		.000[a]
Chipboard	.009		Total		.492
Wraps	.129				
Labels	.006				
Total, material		.634			
Labor					
Boxmaking	.012				
Labeling	.005				
Total, labor		.017			
Total		.651			

[a] The cost of forming cartons and inserting liners will be included with packing labor costs.

Several different cartons manufactured by different firms were available. The "billing out" price for cartons (either impregnated with fungistatic material or with impregnated liners or collars) varied from $228.50 to $252.50 per thousand. Most of the houses contacted in this study were using cartons (with liners) costing $240.00 per thousand or 48 cents for two cartons. The cartons do not require brand labels as these are printed on the carton.

According to information obtained from one of the cooperative packing houses in Group A and checked against information from other sources, the tabulation in Table 8 represents the cost of materials and the cost of making a complete standard wooden box and also the complete cost of two cartons. There would thus appear to be a cost reduction of about 16 cents in favor of cartons.[21/] In the case of non-Group A packing houses, the cost of shook would be 58 cents or about 11 cents more than for Group A houses. The cost reduction for the non-Group A houses by using cartons instead of the standard box would be about 27 cents.

Freight.--The cost of shipping a carload of lemons increases gradually with distance from southern California to reach a maximum at a line drawn roughly north and south through Chicago. East of this line there is a single "blanket" rate. The bulk of fresh shipments of lemons normally is consigned to this eastern one third of the United States. For this reason freight reductions have been computed for the purpose of this study on the basis of the "blanket" rate.

The freight cost for lemons shipped to "blanket" is $1.85 per 100 pounds plus 3 per cent federal tax or a combined freight and tax cost of $1.906. The weight of a standard packed box of lemons is, under the classification regulations currently in force, 87 pounds. Thus, the freight plus tax cost would be .87 of $1.906 or $1.658. The railroads stipulate that a car of fruit shall weigh not less than 36,300 pounds. The customary carloading

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[21/] As has been pointed out Group A is differentiated from the others because they own their own timber and mills for the manufacture of wood shook. If and when the substitution of new box materials should become complete for all varieties, these old investments do not simply disappear; they have an alternative value and constitute a residual gain which, while difficult to measure and not immediately available, is nevertheless real and significant. The authors, however, have not attempted to analyze it.

[illegible]
The "[illegible] out" price for cartons (either impregnated with fungistatic material or with impregnated liners or collars) varied from $225.50 to $252.50 per thousand. Most of the houses contacted in this study were using [illegible] tons. The cartons do not require brand labels as these are printed on the [illegible]

According to information obtained from one of the cooperative packing houses in Group A and checked against information from other sources, the tabulation in Table 8 represents the cost of materials and the cost of making a complete standard wooden box and also the complete cost of two cartons. There would thus appear to be a cost reduction of about 16 cents in favor of cartons.[24] In the case of non-Group A packing houses, the cost of shook would be 57 cents or about 11 cents more than for Group A houses. The cost reduction for the non-Group A houses by using cartons instead of the standard box would be about 27 cents.

Freight.--The cost of shipping a carload of lemons increases gradually with distance from southern California to reach a maximum at a line drawn roughly north and south through Chicago. East of this line there is a single "blanket" rate. The bulk of fresh shipments of lemons normally is consigned to this eastern one third of the United States. For this reason freight reductions have been computed for the purpose of this study on the basis of the [illegible]

The freight cost for lemons shipped to "blanket" is $1.85 per 100 pounds plus 3 per cent Federal tax or a combined freight and tax cost of $1.905. The weight of a standard packed box of lemons is, under the classification regulations currently in force, 87 pounds. Thus, the freight plus tax cost would be .87 of $1.905 or $1.658. The railroads stipulate that a car of fruit shall weigh not less than 36,300 pounds. The customary carloading pattern calls for 464 packed boxes which would have a maximum weight of 40,368 pounds. The total freight plus tax cost on a car of fruit shipped to "blanket" would thus be 464 x $1.658 or about $770. It usually happens, however, that fruit is not heavy enough to reach this weight (for example, fruit has a lower than maximum juice content in relation to bulk) and that a standard box will have a weight of about 85 or 84 pounds.[22/] Under the classification plan, however, freight will be charged at the rate of 87 pounds. In other words, the 84- or 85-pound standard box would bear the same freight cost as the 87-pound box. The cost per pound on this fruit would thus be somewhat higher than where a box weighs a full 87 pounds. For purposes of comparison, however, it will be assumed that a standard box weighs 87 pounds and bears a freight plus tax cost of $1.658.

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[24] As has been pointed out Group A is differentiated from the others because they own their own timber and mills for the manufacture of wood shook. If and when the substitution of new box materials should become complete for all varieties, these old investments do not simply disappear; they have an alternative value and constitute a residual gain which, while difficult to measure and not immediately available, is nevertheless real and significant. The authors, however, have not attempted to analyze it.

Experience of packing houses indicates that a single carton of lemons averages between 40 and 40 1/2 pounds in weight. Using the higher figure, two cartons (the equivalent of the standard) would weigh 81 pounds and would bear a freight plus tax cost of .81 of $1.906 or $1.544. The freight reduction in favor of fruit shipped in cartons would thus be $1.658 minus $1.544 or about 11 cents. This may be regarded as a minimum reduction in freight costs under existing freight regulations. The equivalent of 464 standard boxes would be 928 cartons which would have a combined weight of only 37,584 pounds, or only about 1,300 pounds in excess of the minimum of 36,300. In order to bring up the weight of fruit and cartons more nearly to that of 464 standard boxes, many packing houses are loading in excess of 928 cartons into cars.

Packing Labor Costs.--Packers employed to pack fruit in standard wooden boxes are invariably paid on a piece-work basis--so many cents per 1,000 fruit packed.[23/] While packout sizes vary slightly, the cost of packing under the old system can be estimated with considerable exactness.

With the carton a very different situation exists. At the time this study was begun very few houses had had any extensive experience in handling fruit in cartons and especially in the operation of the volume-fill method.

[22/] Occasionally, packs may run as light as 80 pounds.

[23/] Sizes of lemons are given in terms of the number of fruit that can be packed in a standard wood box. The sizes usually shipped are as follows: 210's, 252's, 300's, 360's, 432's, 490's and 588's.

cartons, while for [illegible] standard boxes which would have a maximum weight of [illegible] pounds. The total freight plus tax cost on boxes of fruit would be [illegible]. It should be noted, however, that fruit is not heavy enough to reach that weight (for example, fruit runs larger than average, which is packed to weight) and that a standard box will have a weight of about 65 or 66 pounds.22/ Under the classification plan, however, freight must be charged at the rate of 87 pounds. In other words, the 65- or 66-pound standard box would bear the same freight cost as the 87-pound box. The cost per pound on this fruit would thus be somewhat higher than where a box met the full 87 pounds. For purposes of comparison, however, it will be assumed that a standard box weighs 87 pounds and bears a freight plus tax cost of [illegible].

Experience of packing houses indicates that a single carton of fruit averages between 40 and 40 1/2 pounds in weight. Using the higher figure, two cartons (the equivalent of the standard) would weigh 81 pounds and would bear a freight plus tax cost of [illegible]. The freight reduction in favor of fruit shipped in cartons would then be [illegible] minus [illegible] or about [illegible] cents. This may be regarded as a minimum reduction in freight costs under existing freight regulations. The equivalent of [illegible] standard boxes would be 920 cartons which would have a combined weight of only 37,260 pounds, or only about 1,300 pounds in excess of the minimum of 36,000. In order to bring up the weight of fruit per car more nearly to that of [illegible] standard boxes, many packing houses are loading in excess of 920 cartons into cars.

Packing Labor Costs.--Packers employed to pack fruit into standard wooden boxes are invariably paid on a piece-work basis--so many cents per 1,000 fruit packed.23/ While packout sizes vary slightly, the cost of packing under the old system can be estimated with considerable exactness.

With the carton a very different situation exists. At the time this study was begun very few houses had had any extensive experience in handling fruit in cartons and especially in the operation of the volume-fill method.

22/ Occasionally, packs may run as light as 60 pounds.

23/ Sizes of lemons are given in terms of the number of fruit that can be packed in a standard wood box. The sizes usually shipped are [illegible]: [illegible]s, 252s, 300s, 360s, [illegible] and [illegible]s.

Of the 10 packing houses contacted in April, 1953,[24] only one had any extensive experience in packing fruit in cartons. This house shipped approximately 25 per cent of all fresh fruit sold in 1950-51 in cartons, using the place-pack method. In 1951-52 it shipped about 95 per cent of all fruit in cartons, one fourth being place packed and three fourths volume filled. Most of the other houses had shipped varying but minor proportions of fruit in cartons in 1951-52 using the place-pack method of fill. All of them had or were installing equipment for volume-fill packing of fruit. Several of the houses had been using the volume-fill method almost exclusively since the beginning of 1953 but were still experiencing operational problems.[25]

An important difficulty arises from the fact that, because of wide seasonal variations in the volume of fruit shipped, packing houses do not usually prepare monthly profit and loss statements. It was thus not possible to make comparisons of the operations of, say, the months of February and March, 1953, when fruit was packed volume fill, with costs for the same months in 1952 when fruit was packed in standard boxes. In any case February and March would not be satisfactory months for cost comparisons because of the small volumes of fruit shipped during those months.

It was found that the wage being paid to experienced packers varied from 65-70 cents per 1,000 fruit packed, the higher being the more common figure. If this figure is used, the cost of packing 210's would be .210 x 70, or 14.7 cents, whereas the cost of packing 588's would be .588 x 70, or about 41.2 cents. Persons familiar with the citrus industry of California consider that the 360 size (the mid-point of the size range) is the most representative size of fruit packed and shipped. If this size is used as the average, the labor cost of packing would be .360 of 70, or 25.2 cents a standard box.

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[24] These houses were selected because they were handling fruit in cartons at the time this study was made and because previous contacts with managers or boards of directors had indicated willingness to cooperate by supplying such data as were available. As these houses are located in four counties, reasonably good coverage of the main lemon-producing areas was obtained.

[25] While data on volume fill were very limited at the time this study was initiated, further information was obtained from three additional packing houses for operations during the month of June, 1953. Two of these were using semiautomatic volume-fill equipment.

Of the 12 packing houses contacted in April, 1953,[24] only one had any extensive experience in packing fruit in cartons. This house shipped approximately 25 per cent of all fresh fruit sold in 1950-51 in cartons, using the place-pack method. In 1951-52 it shipped about 95 per cent of all fruit in cartons; one fourth being place packed and three fourths volume filled. Most of the other houses had shipped varying but minor proportions of fruit in cartons in 1951-52 using the place-pack method of fill. All of them had or were installing equipment for volume-fill packing of fruit. Several of the houses had been using the volume-fill method almost exclusively since the beginning of 1953 but were still experiencing operational problems.[25]

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[24] These houses were selected because they were handling fruit in cartons at the time this study was made and because previous contacts with management of each of them had indicated a willingness to cooperate by supplying such data as were available. As these houses are located in four counties, reasonably good coverage of the main lemon-producing areas was obtained.

[25] While data on volume fill were very limited at the time this study was initiated, further information was obtained from three additional packing houses for operations during the month of June, 1953. Two of these were using semi-automatic volume-fill equipment.

Data available from several different sources indicate that a packing labor cost of 25 cents per standard box for all fruit packed is quite representative. In 1952, a detailed study was made of packing house operations in the Ontario-Cucamonga area.[26/] In this study it was found that in 1950-51 costs of packing labor in the 6 lemon operations studied varied from 22.38 cents to 28.35 cents per packed box. Four of the 6 houses had costs around 23.50 cents. As packing wages have risen at least 5 per cent since 1950-51, this would give an average cost figure for 1952-53 very close to 25 cents per box. Another source gives estimates of packing costs per standard box from 24.48 cents to 25.55 cents.[27/] It appears safe to conclude that in a reasonably efficient packing house average labor costs of packing fruit in standard boxes would be about 25 cents. This figure has, therefore, been accepted for purposes of comparison.

This method of calculating costs of packing a standard box of fruit on the basis of a particular size has one defect. It does not include the cost of training new packers. Managers have presented estimates of this type of cost ranging from 1-5 cents. Several managers stated that, if the standard box method of packing was continued, this cost would probably be somewhat higher in the years ahead because of rising wages and because of an increasingly high turnover of personnel. Although exact data were not readily available, 1.5 cents would appear to be a reasonable approximation of the cost of training packers when fruit is shipped in standard boxes.

In conducting the controlled runs of fruit under the various methods of pack, managers were asked to include in the packing crews the employees engaged in forming cartons and inserting collars, the employees inspecting fill in cartons and the employees engaged in sealing cartons. The two houses which were able to conduct controlled runs presented the data shown in Table 9 on the results of these runs.

Some explanation and interpretation of these data are necessary. In the case of House A, the unit cost of packing a standard box did not include the wages of the lidder and stackers which the manager stated would average about

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[26/] Tinley and Parks, op. cit.

[27/] Smith, Eugene R. Comparison of Lemon Costs. Packed Box Basis, Standard Wood Box and Two One-Half Box Sealed Cartons. Mimeo. September, 1952.

[illegible]

lower cost of 25 cents per standard box for all fruit packed is quite repre-
sentative. [illegible]
[illegible] study it was found that in 1951-52
[illegible] labor [illegible]
producers 2.25 cents per packed box. Four of the 5 houses had costs around
[illegible] have risen at least 5 per cent since 1950-51,
this would give an average cost figure for 1952-53 very close to 25 cents per
box. Another source gives estimates of packing costs per standard box from
21.16 cents to 25.06 cents.[21] It appears safe to conclude that in a reason-
ably efficient packing house average labor costs of packing fruit in standard
[illegible]
purposes of comparison.

This method of estimating costs of packing a standard box of fruit on the basis of a particular [illegible]. It does not include the cost of [illegible]. Managers have presented estimates of this type of cost ranging from [illegible]. Several managers stated that, if the standard box method of [illegible] continued, this cost would probably be somewhat higher in future years than [illegible] because of rising wages and because of an increasing [illegible] turnover of personnel. Although exact data were not readily available, [illegible] cents would appear to be a reasonable approximation of the cost of [illegible] packers when fruit [illegible] shipped in standard boxes.

In calculating the [illegible] of fruit units, the various [illegible] of [illegible] the packing crews the employees engaged in [illegible] cartons and [illegible] the [illegible] in cartons and [illegible]. The two houses which were [illegible] controlled runs presented the data shown in Table 9 on the results of these runs.

[illegible] and interpretation of these data are necessary. In the case of House [illegible], the unit cost of packing a standard box did not include the [illegible]

[illegible]

[21] [illegible] Comparison of [illegible] Costs [illegible]

2 cents a box. According to the manager, the unit costs for cartons (place packed) could not be regarded as significant because of the small number of boxes handled in each run. The manager stated that much larger volumes of fruit could have been handled by the same crew in the same time. The data on volume fill, however, are illuminating. In each successive run the unit costs were reduced, even though the volume of fruit packed in the third run was substantially below that in the second run.

House B was unable to make special test runs on fruit in standard boxes and under the place-pack method. No orders had been received during the test period for fruit in standard boxes. The figure given for place pack was an estimate made at the end of last year when this method was used extensively. Since the beginning of this year, this house has been 100 per cent on volume fill although operational problems were still being encountered in April.

Table 9

Unit cost of packing labor (controlled runs),
(standard box equivalent)

Container and method of pack	Packing House A		Packing House B	
	Number of boxes in run	Cost per box (dollars)	Number of boxes in run	Cost per box (dollars)
Standard box Wrapped	928	.2320	a/	--
	6,662	.2295		
	5,617	.2301		
Cartons: place pack	963	.2989	b/	.2312
	966	.2894		
Cartons: volume fill	4,310	.0877	2,668	.0605
	6,582	.0765	3,500	.0625
	5,318	.0651		

a/ No runs.

b/ Not given.

The managers of both of these packing houses stated that they were convinced that, as the packing crews became more familiar with the volume-fill method of packing, as operating difficulties were overcome, and as larger volumes of fruit were handled in the summer months, costs would be reduced still further.

Packing House C installed volume fill equipment early in 1953 and during July felt it had worked out its major operational problems. The cost tabulation in Table 10 gives a comparison between the 1951-52 season when everything was hand packed, although part of this was a naked pack into cartons, and the 1952-53 season. In particular the most recent four-week period of volume fill operations is shown. The new equipment is a sheerboard operation with a mechanical shaker for settling the fruit.

Table 10

Unit cost of packing labor, House C
(standard box equivalent)

Item	Costs			No. of standard boxes
	1951-52 season	1952-53 season thru 7/25	Period of 6/27/53-7/25/53	
Packing costs				
Hand	.25042	.22501		16638
Volume fill		.08950		39089
" "			.07477	12312
Average packing costs 1952-53		.12996		55727
Grading costs				
Hand pack	.08896	.10065		16638
Volume fill pack		.06297		39089
" " "			.05013	12312
Average grading costs 1952-53		.07422		55727
Misc. labor	.22114	.25930		55727
" "			.22101	12312
Total: Packing, grading and misc.	.56052	.46348	.34591	

The cost reduction for grading and miscellaneous labor arose from the higher and more flexible rate of operation in packing. The number of packing days per given volume of fruit was cut in half and the number of man days in storage and in loading cars could thus be cut in half. Ten graders were found to be capable of handling double the volume of fruit that eight could before in a given number of days run.

Fluctuations in costs are, of course, still very great. This may be illustrated by packing costs in this house for June 30 in the period reported on. On that day 2,873 cartons were packed or 1,436.5 standard boxes. Total wages paid for packing was $87.20, a cost of 6.07 cents per standard box. The average size was very small, 480 per standard box; and the cost under the old wrap pack would have been 33.6 cents per standard box. Evidently small fruit which was so very expensive to pack under the old system is a little less expensive to pack with volume fill than the larger sizes. This cost relationship among sizes is logical as the small sizes settle easier and the top layer can be arranged faster.

Packing House D which uses semi-automatic equipment made an estimate of the cost of packing labor on the basis of 3 weeks of operation. The house employed a crew of 10 girls: 2 folding cartons, 4 filling cartons, 2 sizing fruit, 1 at the shaker and 1 counting. The results, including the wages of the girl doing the sizing, are shown in Table 11.

Table 11

Unit cost of packing labor, House D
(standard box equivalent)

Week	Number of cartons filled	Costs
		(cents)
June 7-13	10,252	4.08
June 14-20	8,660	4.24
June 21-27	8,744	3.81

Packing House E also with semi-automatic equipment had maintained a daily check for nearly 2 weeks on the number of cartons filled and the cost per standard box equivalent. The volume-fill method was used for packing top-grade fruit, whereas second-grade (or "choice") fruit was hand filled, a packing technique halfway between volume fill and place pack. Under this method girls size fruit by sight and fill cartons which are then shaken down and inspected as in the case of the regular volume fill. On volume fill this house employed a crew of 12 girls: 2 folding, 4 filling, 2 at shaker, 3 sizing, and 1 counting. Table 12 shows pack-outs and costs per standard box equivalent.

Table 12

Unit cost of packing labor, House E
(standard box equivalent)

Day, 1953	Volume fill			Hand fill		
	Number of cartons	Number of hours	Cost per standard box equivalent	Number of cartons	Number of hours	Cost per standard box equivalent
			(cents)			(cents)
June 16	3,806	102	5.36	1,116	76.5	13.70
June 17	4,242	102	4.80	721	76.5	21.22
June 18	4,634	102	4.40	676	68	20.12
June 22	4,312	110.5	5.12	724	59.5	16.44
June 23	3,683	102	5.54	856	72	16.82
June 24	4,696	109	4.64	796	68	17.08
June 25	4,246	102	4.80	778	76.5	19.66
June 26	4,176	102	4.88	958	88.5	18.48
June 27	2,559	65	5.08	441	40	18.14
June 29	4,235	102	4.82	917	76	16.58
June 30	4,689	102	5.36	957	80	16.72
July 1	4,873	102	4.18	838	76	18.14

These data also indicate rather clearly the flexibility of operations under the volume-fill method. On July 1 some 4,873 cartons were filled in 102 hours as compared with 3,683 cartons on June 23. It is normally not practical to lay off part of the crew when a smaller volume is being packed. It may be possible, however, with experience so to regulate the volume of fruit packed in any one day so as to avoid extreme fluctuations. These data also indicate the greater economy resulting from volume fill over the hand-fill method used. This house is installing additional equipment to permit volume filling of its second grade fruit as well as of its top-quality fruit.

Unloading Materials: Loading Fruit.--No data were obtained from packing houses relative to comparative costs of unloading shook, cartons, and other packing materials, conveying same to the packing area, and of loading packed fruit in standard boxes and in cartons.[28] In July, 1952, however, in an analysis of packing costs in standard boxes and cartons, Mr. A. W. Stacy

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[28] Packing houses are still experimenting in loading techniques and patterns for cartons.

presented estimates of the range of such costs for the two types of containers.[29] Using the average of high and low costs presented by Stacy, the following tabulation may be made:

Item	Cents per standard box	Cents per 2 cartons
Unloading materials	00.80	00.57
Spreading materials	00.25	00.12
Bulkhead--miscellaneous materials for cars	00.86	--
Paper for lining cars	--	00.15
Labor: Loading cars	01.02	01.82
Labor: Making bulkhead	00.20	--
Total	03.13	02.66

These data indicate a reduction in favor of cartons of nearly one-half cent in the cost of performing these operations.

Lidding of Packed Boxes.--This operation requires the services of a full-time employee (usually a man). It is estimated that the elimination of this employee (not needed in handling of fruit in cartons) would result in a cost reduction of .4 cents.

Other Possible Economies.--All packing house managers interviewed were of the opinion that eventually certain additional economies could be developed in internal plant operations as a result of the use of the volume-fill method of packing. Because most fruit is presorted and sized and is packed unwrapped, little skill is required of packers. Because of this, they anticipate no expense in training packers for volume-filling cartons. Furthermore, because of the apparent greater flexibility of this method, it would be possible to pack much larger volumes of fruit with only minor additions to the packing crew. Moreover, packing labor could be utilized in the plant for other operations (for example, fruit washing) should the occasion arise. Early experience indicated that it would cost very little more to pack small than large fruit. This would be a distinct boon to houses located in areas which produce fruit of small sizes. It would also permit all houses to ship larger quantities of small sizes of fruit which they were unable to handle economically under the old system of packing. Finally, because packers could

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[29] Stacy, A. W. A Study of the Comparison of Costs Between the Standard Wooden Box and the Two One-Half box Sealed Cartons (Packed Box Basis). Confidential report made on July 3, 1952.

[illegible] estimates of the range of such costs for the two types of containers.[1] Using the average of high and low costs presented by Stacy, the following tabulation may be made:

Item	Conventional standard box	Cartons per 2 cartons
Packing materials	$0.60	[illegible]
[illegible]	[illegible]	[illegible]
Materials for pans	0.35	—
Paper for lining pans	—	[illegible]
Labor: Loading pans	[illegible]	[illegible]
Labor: Loading pallets	[illegible]	—
Total	[illegible]	[illegible]

These data indicate a reduction in favor of cartons of nearly one-half cent in the cost of performing these operations.

Saving of [illegible].— [illegible] a full-time [illegible]. It is estimated that the elimination of this employee (not needed in handling of fruit in cartons) would result in a cost [illegible]

Other Possible Economies.— [illegible] of this system, [illegible] certain additional economies could be developed in internal plant operations as a result of the use of the volume-fill method of packing. Because most fruit is presorted and sized and is packed [illegible], little skill is required of packers. Because of that, they anticipate no expense in training packers for volume-filling cartons. Furthermore, because of the apparent greater flexibility of this method, it would be possible to pack much larger volumes of fruit with only minor additions to the existing [illegible]. Moreover, packing labor could be utilized in the plant for other operations (for example, fruit washing) should the occasion arise. [illegible] experience indicated that it would cost very little more to pack small than large fruit. This would be a distinct boon to houses located in areas which produce fruit of small sizes. It would also permit all houses to ship [illegible] quantities of [illegible] of fruit which they were unable to handle [illegible] system of packing. Finally, because packers could also be used to perform other operations, employees would be assured of more regular employment throughout the year. This would have a beneficial effect upon morale and would also probably result in some reduction in the cost of unemployment insurance. The effect of such factors upon plant operating costs and returns, however, cannot be gauged with any degree of accuracy at the present time.

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[1] Stacy, A. W. A Study of the Comparison of Costs Between the Standard Wooden Box and the Two One-Half [illegible] Sealed Cartons ([illegible] Box Cartons). Confidential report made on July 3, 1952.

Refrigeration in Transit.--The opinion is held by all packing house managers that, because of the superior insulating qualities of the corrugated paper carton, it will be possible to effect some reduction in the cost of refrigeration on carloads of fruit shipped during the summer months. Lemons come from storage at an ideal temperature for shipping. Even after the packing operation, there is no need to cool the fruit any further before shipment as the carton prevents a build-up of heat from outside sources. Apparently, lemons in shipment will not build up heat enough to cause any trouble unless the outside temperature is very high. It is believed by some packing house managers that this can be avoided by relatively inexpensive icing practices.

In the past there has been some variation in icing practices where lemons were shipped in standard boxes. One house shipped lemons the year round in boxes without any icing at all, and this practice has been continued with cartons. Some houses on the other hand used ice the year round, though the amount of icing was reduced in the winter months. Other houses used ice only in the warm summer months when the heaviest movement of lemons to market occurred.

The most common icing cost, half-stage standard to New York, is $103 per car. A few houses follow icing practices which raise the cost still higher. Icing costs to points west of New York are, of course, considerably lower than the $103 per car to New York. This cost is probably a conservative estimate for about 75 per cent of the shipments made. On this basis the average cost of refrigeration on all fruit shipped annually would be about 16.6 cents per standard box.

It is well-nigh impossible to predict what refrigeration practices will be adopted finally in regard to shipment of lemons in cartons. These will depend to a considerable extent on experience as to the arrival condition of fruit and on the viewpoints of individual packing house operators. Some packing house managers consider that with the use of cartons refrigeration costs may be reduced as much as 50 per cent.

During the past year several packing houses have shipped fruit experimentally either without refrigeration or with reduced icing. The results of these experiments have not been too conclusive. They indicate that economies can be made in the cost of icing, but the quantitative effects as far as industry-wide refrigeration practices are concerned are not yet available. It is probable that after the end of this summer indicative trends in practices will be estalished.

Probable Increased Costs.--Certain increased costs will be incurred, for the time being at least, by packing houses which are shipping fruit in cartons. These would include an increase in costs for shape sorting of fruit, higher storage costs, and higher depreciation costs.

Many, though not all, of the houses contacted employ 1 or 2 girls sorting fruit on conveyor belts as such fruit comes from the mechanical sizer which sorts fruit only on the basis of diameter. This postmechanical sizing in some instances appears to have been necessary because of defects in the adjustment of the sizer. Based upon work done by the senior author of this report, the cost of hand sorting of lemons by shape will not run above 1 cent per standard box equivalent. This cost may be reduced or even entirely eliminated if improvements can be made in mechanical sizing or if the trade gives more general acceptance to fruit of mixed shapes in cartons. For the purpose of this study, this may be accepted as an increased cost in the volume-fill method of packing cartons.

No satisfactory method has yet been devised to eliminate the standard wooden box from use also as a storage box.[30] So far there has been no experience that would permit definite estimates of the probable average life of standard boxes used for storage nor of the cost of cleaning and repair of boxes. Houses anticipate a probable life for storage boxes of from 4-6 years. Because only a small proportion of fruit is kept in storage as long as six months, it is probable that storage boxes could be used on a average of 3 times a year.

Discussion of this problem with several managers of packing houses indicated that it would be conservative to expect a minimum of at least 10 uses of storage boxes. The cost of a storage box (minus lid) to a Group A packing

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[30] Experiments are underway to devise a more satisfactory and less expensive method of handling lemons in storage.

During the past year several packing houses have shipped fruit experimentally [illegible] These experiments have not been too conclusive. They indicate that economies can be made in the cost of boxing, but the quantitative effects as far as industry-wide widespread practices are concerned are not yet available. It is probable that after the end of this summer indicative trends in practice will be established.

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Discussion of this problem with several managers of packing houses indicated that it would be conservative to expect a minimum of at least [illegible] uses of storage boxes. The cost of a storage box (minus lid) to a citrus packing house would be 40.4 cents for shook, 1 cent for nails, and 1.2 cents for construction labor or a total of 42.6 cents. On the basis of 10 usages, the cost per standard box equivalent would thus be 4.26 cents. Some packing house managers considered that these figures were to high because in their opinion storage boxes would be used more than 10 times before they would have to be discarded.

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[30] Experiments are underway to devise a more satisfactory and less expensive method of handling lemons in storage.

After each use it is necessary to wash, sterilize, and make minor repairs on boxes used for storage purposes. Becuase of lack of experience with multiple use of standard boxes for this purpose, it is difficult to do more than make a rough estimate of such costs. A. W. Stacy and Eugene R. Smith, and several other persons familiar with packing house operations, have made estimates of such costs. These estimates indicate that the cost of cleaning, sterilization, and repairs would be about .25 cents where a storage box was also used for packing and 2 cents where the box received multiple use for storage purposes. For the purpose of this study, it will be assumed that additional cost for cleaning and repair of boxes used exclusively for storage purposes (where fruit is shipped in cartons) will be 2 cents per standard equivalent.[31]

As was stated earlier, the new method of shipping lemons is by no means firmly established. Should this new method for some reason or other be found to be unsatisfactory, it would be necessary for packing houses to revert (perhaps only temporarily) to shipping fruit in standard wooden boxes. For this reason packing houses have installed new carton-handling equipment in addition to the equipment necessary for handling wooden boxes. In some of the houses most of the old equipment has been fully depreciated; in many, however, old equipment was still being depreciated. Regardless of whether or not the old equipment has been fully depreciated, cartons would have to bear the cost of depreciating the new equipment. This can be regarded as an additional cost.

The amount of additional depreciation per standard equivalent to be assessed against cartons would tend to vary between houses depending upon such factors as: (a) the types and costs of new equipment installed; (b) the number of cartons of fruit packed annually; and (c) the depreciation rate used.

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[31] The cost of a storage box for packing houses not in Group A would be 53.4 cents due to the higher cost of shook. For such houses the additional storage cost would be 5.34 cents per standard box equivalent.

boxes would be 4.4 cents for stock, 1 cent for nails, and 1.2 cents for construction labor or a total of 6.6 cents. On the basis of 10 usages, the [illegible]

[illegible] figures were [illegible] in their opinion strawberry boxes would be used more than 10 times before they would have to be discarded.

At present it is necessary to wash, sterilize, and make minor repairs on boxes used for storage purposes. Because of lack of experience with multiple use of standard boxes for this purpose, it is difficult to do more than make a rough estimate of such costs. A. W. Stacy and George B. Smith, and several other persons familiar with packing house operations, have made estimates of such costs. These estimates indicate that the cost of cleaning, sterilization, and repairs would be about .25 cents each time a storage box was used for packing and ½ cents where the box received multiple use for storage purposes. For the purpose of this study, it will be assumed that additional cost for obtaining and repair of boxes used repeatedly for storage purposes (where fruit is shipped in cartons) will be 2 cents per standard equivalent.21/

As was pointed out earlier, the new method of shipping fruit is by no means [illegible]. If the new method for some reason or other is found to be more satisfactory, it would be necessary for packing houses to convert their [illegible] Some packing houses have indicated the [illegible] in addition to the equipment necessary for handling wooden boxes. In some of the houses much of the old equipment has been fully depreciated; in others, however, the equipment was still being depreciated. Regardless of whether or not the old equipment has been fully depreciated, growers would have to bear the cost of depreciating the new equipment. This can be regarded as an additional cost.

The amount of additional depreciation per standard equivalent to be assessed against growers would seem to vary between houses depending upon such factors as: (a) the type and costs of new equipment installed; (b) the number of cartons of fruit packed annually; and (c) the depreciation rate used.

21/ Cost of 2 cents for packing houses not in Group A would be due to the higher cost of stock. For such houses the additional cost would be 5.2 cents per standard box equivalent.

For the purpose of this study, a detailed statement of new equipment installed was obtained from one of the packing houses that was shipping all fruit under the volume-fill method.[32] Some or all of this equipment had been installed in other houses contacted. The total amount of depreciation provided annually in this house would, of course, not vary over the period of depreciation. The cost per standard unit, however, would vary depending upon the number of cartons packed annually. For example, if 800,000 cartons (400,000 standard units) were packed annually, the cost per standard unit would be only half that if only 400,000 cartons were shipped. For the purpose of this study, it is assumed that 400,000 cartons (200,000 standard units) would be packed annually. Although in most packing houses packing equipment (other than mobile equipment) is usually depreciated over a 10-year period, it was considered that, in view of the fact that some of the new equipment may prove to be unsatisfactory, a more conservative policy would be to depreciate such equipment over a 5-year period.[33]

The following tabulation may be regarded as representative of the types and costs of new equipment installed in a medium-sized packing house:

Item	Cost to nearest dollar
1 sizer	$ 3,210
Installation of sizer	3,500
1 vibrator	1,118
1 sealer	5,700
2 motor trucks	2,330
2 batteries and chargers	1,379
Materials for pallets	163
3 gangplank ramps	788
10 pull out belts	1,488
Conveyors with legs	200
Wiring	829
Labor	1,000
Total	$21,705

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[32] This house had, however, not installed semiautomatic or automatic equipment for filling of cartons. Installation of such equipment would result in higher costs for depreciation which would be offset (fully or partially) by lower costs for packing labor.

[33] It is also probable that other equipment in the process of development may result in the early obsolescence of some of the equipment for volume fill now in use.

Annual depreciation on $21,705 at 20 per cent would be $4,341. Assuming that the house will pack 400,000 cartons or 200,000 standard units annually, the cost per standard unit would be about 2.17 cents. Information since obtained from other packing houses would indicate that substantially the same equipment can be installed for several thousand dollars less and that this equipment is capable of handling considerably larger volumes of fruit than the 400,000 cartons used in this calculation. Similarly, the cost of installing all equipment to permit semiautomatic filling of cartons would appear to cost not more than $35,000.

It is not improbable that many packing houses will have an additional depreciation cost of not more than 1.5 cents per standard unit where cartons are manually filled and not more than 3.0 cents where semiautomatic filling equipment is used.

Recapitulation.--Before recapitulating in tabular form the net cost reductions that may be secured by packing houses shipping lemons in cartons rather than in standard wooden boxes, it is necessary to stress again--because at the time this study was made the industry was still in the conversion phase--much of the cost data presented are tentative calculations of minimum cost reductions. Because packing houses were still experiencing operating problems, it is probable that the cost reduction for volume fill is conservative. Other reductions in general packing house costs may be possible. A full year's operation under the volume-fill method will probably be necessary before the extent of such reductions may be determined. It is probable also that only at the end of a full operational year will it be possible to determine the potential reduction in costs of refrigeration. Finally, 2 or 3 years may have to elapse before more definite data are available in regards to increased costs for storage of fruit and depreciation. The recapitulation is shown in Table 13.

The data shown in Table 13 pertain only to cost reductions which, in the opinion of the authors, can be considered immediately available to growers in Group A houses. The net reductions are shown to be $0.389 per standard box equivalent. For growers in non-Group A houses two adjustments would need to be made because of larger billing rates for shook. The standard shipping box costs them 11 cents more so their saving there is 11 cents greater. The wooden storage box needed with the use of cartons would cost them more, so there the cost is increased 1.1 cents, the net difference between Group A and

Annual depreciation on $21,705 at 20 per cent would be $4,341. Assuming that the house will pack 400,000 cartons or 200,000 standard units annually, the cost per standard unit would be about 2.2 cents. Information since obtained from other packing houses would indicate that substantially the same equipment can be installed for several thousand dollars less and that this equipment is capable of handling considerably larger volumes of fruit than the 400,000 cartons used in these calculations. Similarly, the cost of installing all equipment to permit semiautomatic filling of cartons would appear to be not more than $35,000.

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The data shown in Table 13 pertain only to cost reductions which, in the opinion of the authors, can be considered immediately available to growers in Group A houses. The net reductions are shown to be $0.157 per standard box equivalent. For growers in non-Group A houses two adjustments would need to be made because of larger buying rates for shook. The standard shipping box costs them 11 cents more -- their saving there is 11 cents greater. The wooden storage box needed with the use of cartons would cost them more, so there the cost is increased 1.1 cents, the net difference between Group A and

Table 13

Comparison of costs
Standard box and half-box carton
Group A houses

Item	Standard box	Half-box carton (2)	Cost difference	
			decrease	increase
	(dollars per standard box equivalent)			
Materials (billing out prices)				
Standard (incl. construction)	$.651			
Carton (incl. collar and glue)		$.492	$-.159	
Packing labor				
Standard				
Direct (.252)				
Training (.015)	.267			
Carton (volume fill)		.060	-.207	
Freight		1.544		
Standard	1.658		-.114	
Unloading and material spreading and loading cars	.031	.027	-.004	
Total reduced costs			-.484	
Storage box (cost $0.426-- 10 uses)		.043		$+.043
Cleaning and repair		.020		+.020
Shape sorting		.010		+.010
Depreciation (new equipment)		.022		+.022
Total increased costs				+.095
Net cost reduction			$-.389	

non-Group A being 9.9 cents. Non-Group A houses thus can expect to immediately reduce costs by 48.8 cents.

It needs to be emphasized that billing rates have been used in these estimates. A further reduction is found in the discounts offered by manufacturers to jobber purchasers, but have not been included as a specific item for a number of reasons. The analysis would be complex because such discounts exist for both old and new containers. It would be difficult to estimate the distribution of such discounts between jobber purchasers and packing houses. Apparently, however, a further reduction in cost in favor of cartons of about 5 per cent can be looked for.

Partial corroberation of the cost reduction for non-Group A houses is afforded by House F which shipped over 95 per cent of its fruit in 1951-52 in cartons and started the use of volume fill before the summer sales that year. The results are shown in Tables 14 and 15.

Table 14

Operating practices of House F
(standard box equivalent)

Container and packing system	Per cent of fruit handled	
	1950-51	1951-52
Standard box	74	4
Carton: place pack	26	20
Carton: volume fill	0	76

Table 15

Operating costs per unit of House F
(standard box equivalent)

Item	1950-51	1951-52	Decrease
Labor	.6157	.3870	.2287
Materials	.6606	.4203	.2403
Total	1.2763	.8073	.4690

An examination of Table 14 shows the shift in use of containers and in packing techniques between 1950-51 and 1951-52. Table 15 shows a great reduction in both labor and materials between the two years and accompanying the shift in practices. The cost reductions shown for this house were 46.90 cents.

Other Potential Cost Reductions

In the preceding section, an attempt was made to estimate the cost reductions that appear to be immediately available to packing houses which ship lemons in cartons rather than in the standard wooden box. In this section attention will be directed to possible reductions in the cost of marketing lemons in other stages of the marketing channels and which have risen as a result of the use of the new carton. Little tangible data were available at the time this study was undertaken as to the magnitude of these cost reductions, but it is considered necessary to mention all economies in order to accurately describe the revolutionary nature of the new technique of marketing lemons.

Refrigeration.--Mention was made previously of potential reductions in refrigeration costs (page 43). To the extent that such reductions are forthcoming, they will accrue immediately to the benefit of packing houses.

Recooperage.--One of the difficulties in shipping lemons in the standard wooden box is that breakage in transit is considerable. The repair of broken boxes known as recooperage is borne by the railroad companies. Information available indicates that the cost of recooperage averages $12.00 a car or about 2.6 cents a standard box. Experience to date indicates that recooperage on lemons shipped in cartons in negligible. Elimination or reduction of recooperage costs would accrue immediately to the railroad companies.

Maintenance of Fruit Quality.--From a technical viewpoint, it was generally believed by persons in the lemon industry that fruit could not be shipped in a tightly sealed container. The traditional view was that a ventilated package was required. It was, therefore, a matter of surprise to find in some of the early experimental shipments of lemons in cartons that fruit not only arrived in distant markets in commercially acceptable form, but that the condition of fruit was often maintained better than if shipped in standard wooden boxes. There was generally less decay of fruit in cartons. There was less loss of weight due to desiccation. This was particularly

important to chain store managers who had to account for their fruit on a weight basis. Desiccation also tended to impair the appearance of fruit on retail display racks. There is abundant evidence gathered by merchandising agencies in support of these conclusions. It seems probable that this particular characteristic, fruit quality, was the most dynamic single element in the trade acceptance of the new container.

Handling of Boxes; Wholesale Markets.--Large numbers of retail grocery units are too small to handle a full standard box of lemons at a time. In consequence, in many wholesale markets jobbers have followed the practice of sawing the standard wooden box in two. The end with the center head could be nailed together so as to give a fairly presentable half box. The other end, however, was patched with paper and string or rope, or a special box end was nailed in. The resulting half box was unsightly, cumbersome, and weak, and therefore, very undesirable to the retail trade. While the cost of the operation is clouded in a complex of jobber margins, the expense and inconvenience of the practice are obvious. For each such box cut no one has ever suggested a cost below 20 cents per standard box, and a figure of 25 cents would seem a more likely, but still conservative figure. The use of corrugated paper containers eliminated this sawing operation.

Another advantage to some wholesalers was developed by their continuing to use their unit charge on the two half boxes and thus to double their margin. It seems likely this practice will be temporary; competition will force an adjustment.

Some technical faults exist in the carton, however, and these have been particularly pronounced in the wholesale market. The cartons have not stacked as well as the wooden crate and in crowded quarters inability to stack high may cause some inconvenience. The problem was particularly bad in hot, humid weather when the paper would weaken rapidly. Fortunately, newer materials and better box designs are standing up better.

Complaints have also been received regarding the pungent odor of the fungistatic materials used. Also some cartons are difficult to open for inspection. Most of these problems appear to be minor in nature and likely to be overcome as experience is gained and research encouraged.

Retail Markets: Operating Methods.--The common procedure for handling lemons in retail stores is somewhat as follows: Containers of lemons, along with other types of perishable produce, are received by stores and placed in

[illegible]

[illegible] in support of these conclusions. It seems probable that the particular characteristic, fruit quality, was the most important single element in [illegible] of the new container.

Handling of Boxes; Wholesale Markets.--Large numbers of small growers are too small to handle a full standard box of [illegible]. In consequence, in many wholesale markets jobbers have [illegible] the standard wooden box in two. The end with the center head could be nailed together so as to give a fairly presentable half box. The other one, however, was patched with paper and string or rope, or a special box and was [illegible] in. The resulting half box was unsightly, uneconomical, and weak, and therefore, very undesirable to the retail trade. While the cost of the operation is clouded in a complex of jobber margins, the expense and inconvenience of the practice are obvious. For each such box cut no one has ever suggested a cost below 20 cents per standard box, and a figure of 25 cents would seem a more likely, but still conservative figure. The use of corrugated paper containers eliminated this costly operation.

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Some technical faults exist in the cartons, however, and they have been particularly pronounced in the wholesale market. The cartons have not stacked as well as the wooden crate and in crowded quarters their liability to crush [illegible] may cause some inconvenience. The problem was particularly bad [illegible] and better box designs are standing up better.

Complaints have also been received regarding the gumming [illegible] the material is used. Also some cartons are difficult to open for inspection. Most of these problems appear to be minor in nature and likely to be overcome as experience is gained and research advanced.

Retail Markets. Unpacking Methods.--The common method for handling [illegible] with other types of perishable produce, are received by stores and placed in a storage room located at the back of the store. Whenever lemons are needed to fill the display racks, it is customary to convey the container from the storage room to the display rack, rip off the lid, and dump sufficient fruit to fill the display rack. The standard wooden box usually contained far more lemons than could be displayed conveniently in racks or sold in a reasonably short time and any fruit left in the container had to be taken back to storage. Thus, for fruit received in a standard wooden box, 2 and sometimes 3 trips between the storage room and the display racks were necessary. If a full box were displayed in any but the largest stores, shrinkage, decay and a less attractive appearance would inevitably result. If a retailer purchased his fruit from a jobber who sawed his boxes in two, the retailer would be saved some of this expense, inconvenience and fruit loss, but a greater margin had to be paid the jobber so not too much was gained.

Although practices in regard to display of lemons in retail stores vary somewhat in different parts of the country and in different types of retail stores, there is abundant evidence that the great majority (especially chain stores) take off the wraps of almost all fruit when it is displayed or at least before sale. An important proportion prepackage into transparent consumer trays in their wholesale warehouses. If the wraps are left on in the display, the produce clerks must keep collecting them as the customers do the unwrapping and an unsightly display often exists inspite of every care.[34]

The cost of these retail operations is difficult to appraise and there has been no opportunity to carry out a formal research project on the problem. For a period of nearly seven years, however, the senior author has been giving close attention to the matter. Research and executive personnel of merchandising organizations have been contacted and their estimates obtained. Individual store operations have been observed not only in California, but in Chicago, New York and other towns, large and small. In particular, the two authors together recently contacted responsible executives and managers of local chain store organizations. These particular people estimated that it took from 12-15 minutes of a store assistant's time to convey a standard wooden box two trips between the storeroom and the display racks, to open the

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[34] A few stores catering to high income families sell lemons in wraps and unwrap and rewrap every day to assure themselves of offering no decayed fruit. The very great expense is obvious.

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9/ A few stores catering to high income families sell lemons in wraps [illegible] and [illegible] every day to assure themselves of offering no decayed fruit. The very great expense is obvious.

box, and to remove and dispose of wrappers.

In contrast, it is usually possible to handle lemons in cartons from storeroom to display racks in a single trip. In most stores the volume of fruit in a carton corresponds reasonably well with the capacity of storage racks. Less time is needed to open the carton, and no unwrapping of fruit and disposal of wrappers are necessary. Because of the better condition of fruit upon arrival, fruit arriving in cartons can be displayed for a longer time in racks than fruit in wooden boxes. It is estimated that fruit in cartons can be handled from the storeroom to the display racks in from one fourth to one fifth of the time required for wrapped fruit in wooden boxes.

Retail Markets: Cost Reduction.--The net time saved in retail stores on the basis of the above estimates is between 9 and 12 minutes. In the contacts made in Los Angeles, clerical costs were estimated at from 3.0 to 3.5 cents a minute. It should be noted, however, that the national average is close to 2.5 cents.[35] The average reduction in cost would appear then to be at least 20 cents. In places it equals 40 cents a standard box.[36]

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[35] Specifically, average gross earnings per hour in March, 1953, for employees in food and liquor stores was $1.48. Monthly Labor Review, vol. 76, no. 6, p. 681.

[36] Some specific estimates made by experienced people in chain store management with the time of the estimate and the area in mind were as follows:

Oranges 252 and 288 size, unwrapping alone, 16 cents, California, just after World War II. The reference to oranges is pertinent since the problem is the same differing only in magnitude.

Lemons 360 size, unwrapping alone, 20-25 cents, nationwide estimate, late 1940's.

Lemons and oranges, all sizes, unwrapping alone, 25 cents, Philadelphia, 1950.

Lemons, 360 size, unwrapping and handling, wholesale and retail, all cost reductions of carton compared with old standard box, New York City, 1952.

It is pertinent here to point out that this question of the cost of unwrapping fruit in retail stores was a major factor in bringing about the investigation which led to the development of the lemon carton. For many years a controversy had existed as to the need for citrus fruit wraps. Retail store representatives wanted them left off because of the cost of unwrapping. Lemon merchandising organizations felt they should be used because otherwise there would be an increase in shrinkage, bruising and decay in the wooden crate. This controversy was repeatedly brought to the attention of the senior author and of the Ventura County Citrus Growers Committee who together initiated the lemon packaging study. The objective set up was to eliminate unwrapping, perhaps by use of transparent wrap, perhaps by use of consumer package, perhaps by a shipping package which would maintain fruit quality even though no wrap was used. In the experiments with a transparent wrap

These calculations of retail cost reductions, however, are in part hypothetical; their translation into cash cost reductions by store management may be most difficult. The problem involved has been pointed up by arguments that unless a store's labor load cash cost is specifically reduced, no cost reductions can be claimed. In the authors' view this argument ignores the realities of retail store economy.

In the first place, cost reductions in terms of labor are discrete items and rarely if ever in retail operations correspond to a specific employment. It is not often that the labor load can be reduced in exactly the given amount. A certain proportion of such labor time reductions, however, do hit upon situations where as a result the labor load can be reduced and then the cash savings are extreme; but, of course, do not represent fairly the specific operational change which brought about the reduction in labor load. To be logical we should deal with the average.

More commonly certain labor time is released for other duties. In a retail store there is always work to be done. The advantage of getting these other tasks done presents, of course, a problem for which no simple calculation will suffice if exactness is wanted and we will not attempt it here, but it would appear to be logical to assign an average wage evaluation to the item.

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some hundreds of shipments were made by various packing houses.

See: Roy J. Smith. Memorandum on Pliofilm Usage Tests. To Ventura County Citrus Growers Committee, Santa Paula, California. July 7, 1949. Mimeographed. 7pp. (Division of Agricultural Economics, University of California) The following quotation is of interest: "...the most important objectives of these studies are improvements in marketing at the retail outlet and in the home. A transparent wrap will not be taken off at the grocery store. Estimated savings in labor are 21 cents for 360 lemons and 16 cents for 252 oranges." p. 7.

_____________ Memorandum on Pliofilm Wrap Tests on Lemons. To Ventura County Citrus Growers Committee, Santa Paula, California. September 26, 1949. Mimeographed. 2pp. 3 tables attached. (Division of Agricultural Economics, University of California)

_____________ Memorandum on Wrapping Machine being Built by Hudson-Sharp Machine Company. To Ventura County Citrus Growers Committee, Santa Paula, California. May 31, 1950. Typewritten. 3pp. (Division of Agricultural Economics, University of California)

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[illegible] Memorandum on [illegible] Tests on [illegible] 2[illegible], 19[illegible]. Mimeographed. 2pp. 3 [illegible] attached. (Division of Agricultural Economics, University of California)

[illegible] Memorandum on Wrapping Machine being Built by [illegible]. To [illegible] County Citrus Growers Committee, [illegible]

Finally, a difficult and disagreeable task is eliminated. Women may not and most men should not handle packages weighing 85 pounds. Unwrapping fruit is a most boring task. Most store operators were emphatic in stating that retail stores are experiencing increasingly great difficulty in securing and keeping store assistants. The elimination of any task is an advantage and one of this character is most fortunate.

These three forms of advantages to the retail store are difficult to measure except in terms of labor cost reduction. Time is required, perhaps, before a store can realize it in its accounts. The impact, however, is there and the investigator has no recourse but to accept it at face value.

Factors Governing Trade Acceptance

The first local shipment of lemons in cartons took place in April, 1951; the first eastern shipment, about 3 months later. Yet, by April, 1953, just 2 years later, nearly 80 per cent of all lemons sold fresh were in cartons. This spectacular shift from standard wooden boxes to paper cartons cannot be explained simply from the supply side. Although individual packing houses pushed the sales of lemons in cartons, there was no concerted industry-wide effort to induce the wholesale and retail trade to accept the new container. As has been pointed out wholesalers found some definite disadvantages in the container and they can hardly be credited with initiating the demand.

The conclusion seems inevitable that it is in the retail stores that there is to be found a prime reason for the rapid conversion to the carton. The greater attractiveness and improved maintenance of fruit quality apparently was of first importance. The half box unit was a more logical unit of sale. Reductions in operating cost both in terms of fruit quality maintenance and in terms of labor requirements gave a solid basis for the demand. So obvious and pressing were these factors that from the earliest days of the carton, premiums were commonly paid for it.

Because of limitations of personnel and time, it has not been possible to undertake a detailed study of the demand side of the market for lemons in the new container. It is the view of the authors that such a study would be of value to the lemon industry. The experience with the carton has demonstrated that giving attention to the needs and viewpoint of retail store outlets can have a most beneficial effect on the entirety of the market mechanisms and practices. It is the retailer who in the last analysis sells the fruit to the consumer.

Finally, a difficult and disagreeable [illegible] and [illegible] not handle packages weighing 65 pounds. [illegible] fruit [illegible] boring back. [illegible] were [illegible] that [illegible] helping of [illegible]. The elimination of any task is, [illegible] one of this character [illegible] fortunate.

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Who Will Benefit?

In previous sections it was shown that the shipment of lemons in cartons rather than in the standard wooden box has resulted in substantial cost reductions in the packing, transportation and retailing of lemons. These cost reductions are likely to have an important bearing on the future of the lemon industry. It is necessary, therefore, to give attention to the question of what groups will benefit therefrom. Economists commonly refer to the question as one of incidence; the question being what group will gain the advantage or disadvantage from an increase or decrease in costs.

An answer to this question is complicated by the facts that (a) the incidence of such benefits is likely to be different in the short and long run; (b) broad assumptions as to the competitive situation within the industry may not accord too closely to actual conditions in operation or future changes in such conditions; and (c) new and unforeseen circumstances may arise which may substantially modify the demand and supply situation for lemons.

Students of economic theory are generally agreed that, in an industry in which there is full and free competition and in which the factors of production can be shifted readily from one field of production to another, the benefits arising from cost-reducing technological changes will, in a reasonably short period of time, be passed on to consumers in the form of lower prices. Producers, processors, or marketing agencies may secure the initial benefits, but if these benefits result in returns in excess of long-term or normal costs, output will be expanded. The larger output would be sold only at lower prices so that in the course of time consumers would be the primary recipients of the benefits arising from technological improvements.

It is generally recognized by economists, however, that many industries do not operate in a free competitive manner and, furthermore, that, for biological and other reasons, factors of production cannot be shifted readily from one branch of production to another. Even where such shifts can be made, several years may elapse before the increased volume of output becomes available for the market. The "long run" may, therefore, involve a considerable number of years. The longer the time that elapses between the initial stimulus toward increased production and the eventual increase in output, the more

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Finally, it is necessary to realize that there are differneces in the elasticities of demand for different types of products. Logical reasoning plus statistical studies have shown that the demand for many foodstuffs or groups of foodstuffs is relatively inelastic. In other words, a moderate decrease in price (say, 10 per cent) will result in a relatively smaller increase (say, 5 per cent) in the volume taken off the market. Or, put in another way, a moderate increase in volume of output (say, 5 per cent) will result in a relatively greater decrease (say, 10 per cent) in the price if all the product is to be taken off the market.

Bearing these basic ideas in mind, it can be stated that in the short run the benefits of cost reductions made by packing houses by handling lemons in cartons will accrue to individual houses. Because most of the packing houses are operated cooperatively, the benefits will accrue to growers in the form of higher net prices for fruit delivered. Becuase of the competitive situation, the commercial houses will also pass on most of the cost reductions to growers from whom they purchase fruit. Similarly, the cost reduction that may accrue to railroads (reduction of recooperage costs), to jobbers (elimination of box-halving operations), and to produce warehouses and retail stores (reductions in costs of unwrapping fruit and of spoilage) will accrue immediately to each of these groups.

As regards the jobbers and retail stores, the reductions in costs will in effect mean an increase in net returns from handling lemons. Competition within each of these two segments (the jobbing and wholesale segment and the retail store segment) of the marketing structure is very keen and will cause these two groups to pass on an important portion of these benefits to producers and consumers, the division between these two depending on the elasticity of demand and on such new supplies as may be forthcoming.

Just what demand elasticity exists in the lemon market is quite beyond the scope of this paper. The matter has been studied statistically, and conclusions have been uniform that the market is inelastic though a lesser degree of inelasticity exists at the retail level than at the f.o.b. level

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[37] For example, a general rise in the price level, an increase in population, a change in purchasing power or consumption habits of consumers, or the development of substitute products.

or the on-tree level.[38] The evidence is not clear cut, however, and with the highly dynamic situation occasioned by both fresh lemon and lemon product market developments, it would appear wise to assume that the elasticity of demand for lemons at the retail level is unknown. Pertinent to this thinking, it is useful to remind ourselves that apparently the quality of fresh fruit and the ease of its distribution have been improved with the new box. The lowered costs for retail firms make the handling of lemons more attractive to them and the tendency will be to try to expand it. Thus, an enlarged market for fresh lemons could be in process of development (or possibly a greater market retained from the incursion of products).

If demand at the retail level should be inelastic and if retail firms lowered their margins (in response to lowered costs and to competition), one might, at first glance, assume that consumers would benefit greatly; that is, they could buy at much lower prices. But with demand inelastic, retail firms which attempted to lower their sales prices would not be able to increase their volume of dollar sales proportionately; they would, in fact, have to accept a lower dollar volume of business. Moreover, even though inelastic, there must occur some increase in quantity taken at the new lower prices, and retail firms would be forced to compete in the wholesale market for these needed extra supplies. Under such conditions, the feasibility of consumers benefiting in this fresh lemon market from these retail cost reductions would appear to finally depend on the offering by packing houses of added lemon supplies and of very sharp competition among retail firms for the purchase and sale of these increased offerings. Producers would absorb some of the reduction in margin.

If demand at the retail level were elastic, a somewhat different situation would prevail. Price reductions by retail firms comparable to cost reductions would meet with a more than proportionate increase in quantity taken with a consequent increase in total dollar business. Consumers would benefit. This development assumes, however, that packing houses would offer a materially greater volume of fresh lemons. If packing houses did not offer a much greater volume, retail firms would quickly raise their buying price to obtain

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[38] Kuznets, G. M. "Domestic Demand for Lemons." California Agriculture, vol. 4, no. 10, p. 2.

Hoos and Seltzer, op. cit.

lemons needed to supply consumers at any lower selling price, and these retail firms would see their new wide-profit margin quickly disappear. Producers would still stand to gain an important part of the cost reductions in the retail level because any price reduction that did occur must be accompanied by an important increase in the quantity of lemons taken.

The limiting factor for consumer benefit in the cost reduction in retail levels is the limitation in supplies, and it applies regardless of elasticity conditions, differing only in degree.[39]

The critical question that arises then is whether or not the volume of lemons offered in the fresh market will be expanded. It was shown earlier (page 3) that, although bearing acreage in lemons expanded rapidly between 1935-36 and 1946-47, bearing acreage has declined significantly since the latter year. Furthermore, the production of lemons per acre has tended since 1940-41 to decline. The unfavorable relationships between returns to growers and cultural and marketing costs (page 20) would indicate that, unless net returns to growers were enhanced, a further decline in acreage and yield may be in prospect for the years ahead. If the trends in bearing acreage since 1946-47 continue, consumers may eventually be faced with the prospect of paying higher prices for lemons whether fresh or in products. The cost reductions which growers of citrus fruit are enjoying will have the effect first of retarding the decline in bearing acreage. Many growers with low-yielding acreage will be able to stay in business.

If the increased returns to growers are of great magnitude, there will be a tendency for acreage planted to lemons to increase in the years ahead. Many years, however, are likely to elapse before the output of lemons (in response to favorable price stimulus) can be increased substantially. Under existing cultural conditions, it takes 3 years to bring a lemon seed through budding and selection stages to field planting. Normally, a further 6 years will elapse before the planted tree produces enough fruit annually to cover cultural costs and be considered in significant production. Becuase of the long period that must elapse between increased planting and final increased output of fruit, growers are naturally hesitant about making the considerable

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[39] One might discuss the question in terms of relative elasticity between demand and supply. In any case it is assumed that any change in supplies of fresh fruit is occasioned by the cost reductions and is limited by the corresponding points on the supply curve.

investment needed to increase acreage. This production complication may further postpone the time when a greatly increased supply results from the favorable return stimulus.

One could suggest an increase in production on present acreage, but, as shown earlier, present trends appear to be downward and, aside from normal year-to-year fluctuations, no important increase in yields need be looked for. If these fluctuations should be great, however, they could well dominate the factors that control the incidence of these cost reductions.

The only source for increased supplies in the immediate future is diversion back from products outlets of the high percentage now so marketed, and the new low costs of fresh fruit selling obviously offer an inducement to do that. Here, however, we have another major development which will certainly limit any such action. New lemon products are being offered in the markets and are being accepted in great volume. In 1951-52, canned single-strength juice and frozen concentrate together were sold in an amount equivalent to 2,294,000 packed boxes, approximately a million box equivalent more than in the previous year.[40] Prices, while not equivalent to that sold as fresh, were still attractive. The fresh market does not seem to be disrupted. The current trend in sales is strongly upward. The products outlet appears likely to offer strong competition to fresh lemon outlets for producers' offerings.

If, however, the consumer is to benefit in the near future from these cost reductions, even in the retail segments, a specific diversion of products back to fresh fruit outlets would appear to be necessary. The decision to do that will require consideration of price expectations in the new products outlets and of the elasticity of demand in the fresh fruit outlets in response to increased volume. It would seem pertinent here to recollect that the elasticily of demand at the on-tree level is less elastic than at the retail level. Based on past experience, an assumption by growers of some inelasticity might be expected. With such inelastic conditions assumed, growers will be reluctant, purposely and in concert, to increase fresh lemon supplies, for, by definition, they could expect in return lower dollar

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[40] Figure 3 and Table 2.

[illegible] ate return stimulus.

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[10/] Figure 3 and Table 2.

receipts.[41]

If on-tree returns were equivalent between the two outlets, no such diversion would occur, but if these returns were not equivalent and diversion back to fresh outlets were to take place, it would bring considerable and immediate advantage to consumers, at least as far as fresh fruit sales are concerned. If the diversion were extensive enough, consumer benefits would not be limited simply by cost reductions in the retail level but, inevitably, would reach farther and farther back and would engulf all these reductions listed, even at the packing house level. Such absorbtion is inevitable in time if planting or yield production responses have time to make their influence felt. By that time, however, competitive crops and competitive foods will be playing new parts and the economist would be rash indeed who would project his data ahead that far.

This immediate problem is one of balancing on the one hand the gain to producers of shifting some percentage of supplies from products to fresh sales, and, on the other hand, producers' loss to consumers through over-all lower fresh fruit prices. Any impact of improved fresh fruit quality and unit of sale is highly pertinent here and also highly complicating. There is a balance in such redistribution of supplies which would give maximum returns. The consumers' advantage is that this point would also maximuze the temptation of growers to increase plantings and yields.

For some time to come producers appear to be in a most strategic position relative to these cost reductions. Retail firms will be tempted greatly to offer lower prices to their consumers, particularly if elastic demand conditions previal, but the problem of obtaining increased supplies will be the deterrent.

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[41] It is assumed that the distribution achieved in the past among outlets has resulted in a maximum return. For a discussion of this point, see: Hoos and Seltzer, op. cit.

Summary

The purpose of this study is to analyze the economic impact of a revolutionary change in marketing lemons. In a little over two years from the initial trial, a new package is being used for over 80 per cent of fresh domestic shipments. The package permits the use of a new low cost packaging technique which is immediately being put into use by most houses. With the adoption of the new package cost reductions are immediately available to packing houses. Moreover, cost reductions are found to exist in transportation, in refrigeration, in many wholesale markets and particularly in retail stores.

The method of analysis has been to present a broad picture of the industry's general economic situation, to tabulate existing data on cost reductions, and finally to estimate the incidence of these cost reductions.

The general economic position of the industry relative to competing crops was not strong after World War II. While there was considerable planting in some areas, it was balanced by a loss in acreage elsewhere. Consumption of fresh fruit, by far the most important outlet, apparently was declining.

Since 1948, however, important new juice products have been offered consumers, and these have been so favorably received that the general outlook has been better. This development has been very important because there had been in being for a number of years a well-established and purposeful diversion of the crop to lemon products which, until these new products were offered, brought in negligible returns. Since this diversion in total had grown to approximately one third of the crop, the impact of these new juice products has been significant in terms of grower returns.

Our problem, however, has to do with fresh fruit. The cost reductions analyzed here for marketing this fruit are divided into two groups, those immediately available to packing houses and thus to producers, and those which are not so immediately available either to consumers or producers and which in addition often are not so easily measured. In this summary attention will be given only to the new volume fill technique of packaging as the place packing of cartons has been largely abandoned by the time of this writing, September, 1953.

SUMMARY

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The comparisons made in costs of package material has been complicated by important differences within the industry in methods of obtaining shook for the old standard boxes. Much the larger segment of the industry (Group A) owns its own timber and mills which gives them a materially lower billing rate for shook. The other houses (non-Group A) can be considered to have shook costs 11 cents higher per standard box than those listed below, and consequently to have achieved by the amount, greater immediate cash cost reductions by the adoption on the half box carton. Group A houses, of course, if conversion should be complete for all varieties, would find themselves with holdings having an important residual value but no appraisal of this factor has been attempted.

Also no attempt has been made to appraise the net effect of discounts from billing rates which exist in the industry. As of the date of this writing, however, they can be regarded as offering a further advantage to the use of the carton, perhaps of 5 per cent in its cost.

The following tabulation of costs and of cost reductions or increases is for Group A houses alone, using the volume fill technique in packaging. These cost reductions can be considered as the minimum immediately available to growers.

	Standard wood box	Half-box carton (2)	Cost reduction (-)	Cost increase (+)
Package material	$.651	$.492	-$.159	
Packing house labor	.267	.060	- .207	
Freight	1.658	1.544	- .114	
Unloading box materials and loading cars	.031	.027	- .004	
Storage box		.063		+$.063
Shape sorting	.0	.010		+ .010
Depreciation (new)	.0	.022		+ .022
Net cost reduction			- .389	

This reduction in costs has been absorbed already in an important degree by producers. Moreover, as indicated, there is good reason for thinking that their advantage will be improved still further with time in these particular items alone.

There are, however, other cost reductions resulting from these technical changes which are of equal importance but which unfortunately are less easily subject to analysis and measurement.

The carton is an excellent insulator. Consequently, lemons which normally are taken out of storage at a temperature ideal for shipping need less ice with the carton than with the ventilated wooden box. A purely tentative estimate may be made that 8 cents a standard box will be the average overall reduction in cost.

The wooden box was easily damaged in transit and a continual series of damage claims were made against the railroads. On the other hand, the carton is almost never damaged and even if broken, no fruit is hurt. The reduction in cost for railroads is estimated at 2.6 cents a box.

Because the standard box was larger than the trade wanted, a very common practice for jobbers was to saw it in two. The resulting package was unsightly and difficult to handle, but retailers were saved some expense in decay and shrinkage and so often preferred it over the whole box. Nothing like this sawing is required for the new package. The extent of the old practice, while very large, is not known nor are its costs. It is difficult to visualize the cost for such boxes as were actually cut, however, as less than 25 cents per standard box.

In the retail store there appears to have been a cost reduction comparable to that in the packing house though not so easily defined and examined. The new package not only is easier to handle, but requires less handling. Once emptied, it has a value at the sales counter for carrying out groceries. Most important, no unwrapping is required. Hypothetical time and wage calculations indicate a reduction in cost of from 20 to over 40 cents per standard box. The translation of such figures into reduction in actual labor load cost is, of course, difficult for retail store management and time will be required for its impact in an accounting sense to be felt. In the highly dynamic and competitive situation in which modern retailing finds itself, this particular opportunity is only one of many and the only practical viewpoint for the investigator is to take at face value the reduction in time and effort requirement on the part of produce clerks.

Perhaps of most importance is the effect on quality of lemons as offered consumers. Industry tradition was that lemons would not keep in such a container. Experience, however, appears to have demonstrated that the new

container offers significant improvements over the old. There is less decay and less shrinkage and the fruit has a more attractive appearance. This improvement could well lead to larger sales, particularly since the smaller package widens the distribution among small stores and the greater immediate net margin of profits in stores would encourage them to press lemon sales. Any attempt to define with exactness these developments is utterly impractical but they certainly are tendencies. Of greatest interest, perhaps, will be the strength of competition to force retailers to disperse their cost reductions between consumers and producers.

The normal reaction of growers and marketing agencies to important cost reductions in terms of increased production is complicated by the fact that cultural factors make any expansion of acreage or increase in yield a very long time matter and by the fact that the diversion back to fresh shipments of the percentage of fruit now going into products is one requiring industry decision. Any such diversion back to fresh sales of the percentage now going to products must overcome the new higher returns being received for the new juice products. Some diversion back can easily be argued for, but any great increase in fresh offerings is certainly going to increase the consumers' share of the advantage gained from these cost reductions. What new balance between the two outlets would maximize returns to growers and thus maximize any increase in production is unknown.

It is obvious that every effort should be made to exploit to the fullest the cost reductions made possible by these technical developments. No economic problem exists there, it is only a matter of organization and work. Fortunately the majority of agencies are pressing the opportunity to the utmost.

There is a problem, however, in the division of production between the fresh and the products markets. The division made will have a decisive effect on the question of who will benefit from these cost reductions. In making this decision, the lemon merchandising organizations are faced with most difficult questions.

Producers and virtually all factors in the channels of trade have already benefited materially. The consumer gains advantage more slowly, however. His position has been immediately improved in terms of quality and distribution and inevitably with time will improve in terms of price, but only as increased supplies are made available.

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